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Golder Associates

REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN

APPENDIX A
DRAFT
SAMPLING AND ANALYSIS PLAN

WEST LAKE LANDFILL
OPERABLE UNIT 2
BRIDGETON, MISSOURI

Prepared For:

Laidlaw Waste Systems (Bridgeton) Inc.
c/o Bridgeton Sanitary Landfill
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April 1995

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REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN

APPENDIX A-1
DRAFT
FIELD SAMPLING PLAN

WEST LAKE LANDFILL
OPERABLE UNIT 2
BRIDGETON, MISSOURI

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1.0 INTRODUCTION

Laidlaw Waste Systems (Bridgeton), Inc. (Laidlaw) has retained Golder Associates, Inc. to conduct a Remedial Investigation/Feasibility Study (RI/FS) at the West Lake Landfill site in Bridgeton, Missouri (hereinafter referred to as the "Site"). The RI/FS will be conducted pursuant to an *Administrative Order on Consent* (AOC) issued by the United States Environmental Protection Agency (EPA), Region VII, CERCLA Docket No. VII-94-F-0025 (EPA, 1994b). The site has been divided into two distinct sections: Operable Unit 1 and Operable Unit 2. Operable Unit 1 (OU-1) comprises the portions of the site (Areas 1 and 2) within which radiologically - contaminated soils were reportedly disposed. Operable Unit 2 (OU-2) comprises the remainder of the West Lake Landfill site, including the currently operating LWS-Bridgeton Sanitary Landfill. Figure 1-1 represents a site map depicting the major components of the West Lake Landfill site.

This Field Sampling Plan (FSP) is one of two parts to Appendix A (Sampling and Analysis Plan) of the West Lake Landfill Operable Unit 2 Remedial Investigation/Feasibility Study (OU-2 RI/FS) Work Plan (hereinafter referred to as the Work Plan). The FSP is Appendix A-1 and is intended to be used in conjunction with Appendix A-2, the Quality Assurance Project Plan (QAPP). The FSP has been prepared in accordance with the follow EPA guidance:

- ▹ *Guidance For Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Draft)* (EPA, 1988f);
- ▹ *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (EPA, 1991e);
- ▹ *Streamlining the RI/FS for CERCLA Municipal Landfill Sites* (EPA, 1990);

- *Presumptive Remedy for Municipal Landfill Sites* (EPA, 1993a); and,
- Other documents listed in Section 8.0 of OU-2 RI/FS Work Plan.

As part of the RI/FS Work Plan, this Field Sampling Plan (FSP) will serve as a guide for those field activities in which environmental samples and field measurements will be obtained. The FSP provides a detailed description of the methods and procedures that will be used to perform each of the RI/FS field tasks.

The FSP has been organized into nine sections including this Introduction. Section 2.0 provides a summary of the background for the West Lake Landfill site. Section 3.0 provides a review of the objectives and rationale for the major components of the field program. Section 4.0 discusses sampling locations and frequency, and Section 5.0 reviews the protocol for establishing the sample designations. Section 6.0 provides a detailed description of the sampling equipment, methods and procedures that will be utilized to perform the RI field program. Section 7.0 reviews the procedures for sample handling and analysis, and Section 8.0 describes decontamination procedures. Section 9.0 reviews the management approach for investigation-derived waste. References for this document are included in Section 8.0 of the Work Plan.

REV.	DATE	DESCRIPTION	DR. BY	APP. BY

CLIENT/PROJECT: LAIDLAW — LAIDLAW WASTE SYSTEMS INC.

WEST LAKE LANDFILL
OPERABLE UNIT 2

TITLE: SITE FEATURES MAP

Golder Associates — Denver, Colorado

DRAWN	TMC	DATE	APRIL 1995
CHECKED	CER	SCALE	AS SHOWN
REVIEWED	WEH	JOB NO.	943-2848
APPROVED		DWG. NO.	D030
FILE NO.	2848D030	FIGURE	1-1

2.0 SITE BACKGROUND

Complete details of the site background and operational history are provided in Section 2.5 of the Work Plan. The following paragraphs summarize pertinent aspects of the site background.

The site was used for agricultural purposes until 1939, when limestone quarrying operations were initiated in the eastern portion of the site. Quarrying continued until economically-recoverable reserves were exhausted in 1988. Mine spoils were deposited on adjacent land immediately to the west of the quarry, within the OU-2 study area. Limestone, concrete, and asphalt processing was conducted on-site during quarry operations; asphalt and concrete activities continue to date. The processing operations were conducted primarily in the central portion of the facility. Concrete processing was conducted in the central and northern portion.

Based on available data, solid waste disposal may have begun at the site as early as 1952 (Midwest Environmental, 1994), although many sources cite 1962 as the initiation date for waste disposal. Waste disposal in Missouri was regulated solely by St. Louis County authorities until 1974, when the Missouri Department of Natural Resources (MDNR) was formed. At the West Lake site, the MDNR closed certain waste disposal sites on the northern portion of the site and issued State permits for disposal of sanitary and demolition wastes in other areas. Waste disposal continued during and after cessation of mining activities, using the quarry pits as landfill cells. The MDNR permit areas are highlighted on Figure 2-4 of the Work Plan and discussed in detail in Work Plan Section 2.4.3.2.

Radiological wastes consisting of 700 tons of uranium contained in 8,700 tons of barium sulfate, and mixed with 39,000 tons of soil, were reportedly disposed of in two portions of the site in 1973, now comprising OU-1 (Areas 1 and 2, Figure 1-1). The site was placed on the National

Priorities List (NPL) in 1990, based primarily on the presence of radiological isotopes and the associated potential for groundwater contamination. Operable Unit 1 is being characterized under *Administrative Order on Consent*, Docket No. VII-93-F-0005 (EPA, 1993b).

To date, OU-1 activities have included preparation of an RI/FS Work Plan and associated documents (McLaren/Hart, 1994a), as well as completion of an overland gamma survey designed to identify the extent of radiological contamination within and near OU-1 Areas 1 and 2 (McLaren/Hart, 1994b).

Characterization of OU-2 is the subject of this RI/FS Work Plan. As previously stated, this FSP supports the tasks described in the Work Plan.

3.0 SAMPLING OBJECTIVES

The following portions of Section 3.0 present an overview of the proposed RI/FS field activities. Detailed descriptions of the procedures to be employed during field activities are presented in Sections 4.0 through 9.0 of this FSP.

3.1 Project Objectives

The primary objectives of the West Lake Landfill OU-2 RI are to collect data on and adjacent to OU-2 regarding environmental characteristics, chemical occurrence, potential chemical migration pathways, and transport mechanisms. Data from the RI will be evaluated to assess risk to human health and the environment and to determine the most feasible options for remediation, including no action. In addition, the research and field activities relating to the RI will be incorporated into the design of the ground water monitoring system for the currently operating Bridgeton Landfill. Finally, data collection activities for certain FS tasks will provide information which will assist in the design of remedial alternatives.

The scope of field program activities, data quality levels, and rationale for tasks are summarized in the following sections. Sampling locations and frequencies are provided in Section 4.0, sample designations are described in Section 5.0, and sampling procedures are detailed in Section 6.0. Details of laboratory analytical protocols, QA/QC sampling requirements, and chain-of-custody are presented in the Quality Assurance Project Plan (QAPP) (Appendix A-2 of the Work Plan).

3.2 Scope of Field Activities

3.2.1 RI Field Program

The Remedial Investigation field program will include the following specific tasks and subtasks:

- ▹ Define site physical and biological characteristics:
    - Surficial geologic investigation;
    - Ecological evaluation;
    - Collection of additional information on site physical characteristics and demographics;

- ▹ Characterize site hydrogeologic characteristics:
    - Evaluation of existing well integrity;
    - Initial hydrogeologic investigation;
    - Technical memorandum recommending groundwater quality monitoring network;
    - Determine groundwater quality;

- ▹ Define sources of contamination:
    - Leachate sampling and analysis;
    - Landfill gas characterization;
    - Investigation of potential petroleum impacts near well MW-F2;
    - Evaluation of potential impacts to groundwater;

- ▹ Determine surface water and sediment quality;
    - Surface water sampling and analysis;
    - Seep survey, sampling, and analysis; and,

- ▹ Determine air quality.

3.2.2 FS Field Program

The Feasibility Study field program will consist of the following task:

- ▷ Geotechnical landfill cap investigation.

The rationale for the RI/FS investigative program is discussed in detail in Section 3.4 of this FSP.

3.3 Data Quality

Analytical data will be obtained at three different levels, based on criteria provided in *Data Quality Objectives for Remedial Response Activities: Volume 1, Development Process*, (EPA, 1987b), as described below:

> Level I - Field Screening - This level is characterized by the use of portable instruments, such as a photoionization detector (PID) and/or combustible gas indicator (CGI), that can provide real-time data to assist in the optimization of samples for laboratory analysis and for health and safety monitoring. Qualitative data can be generated regarding the presence or absence of certain types of contaminants (i.e., volatile organic compounds) at sampling locations. However, results are generally not chemical specific and are not quantitative. Level I analysis will be used throughout the OU-2 RI.
>
> Level II - Field Analyses - This level uses more sophisticated portable analytical instruments, either on-site or in a mobile laboratory. Examples of on-site field instrumentation include pH, temperature, specific conductivity, and turbidity meters used to measure field parameters during groundwater well development and purging. Qualitative and quantitative data can be generated for certain compounds depending on the type of contaminant, sample matrix analytical procedures, and skills of the personnel.
>
> Level III - Laboratory Analyses - This level refers to analyses conducted by standard, documented laboratory procedures in a laboratory. Level III analyses may be performed under non-contract laboratory program guidelines. Level III will be used for all chemical and geotechnical analyses during the OU-2 RI.

Data quality needs and data quality objectives (DQOs) are discussed in Section 4.1 of the Work Plan and detailed in the QAPP (Appendix A-2 of the Work Plan). Table 3-1 summarizes the DQOs and QA/QC samples associated with the investigative tasks.

3.4 Rationale for RI Field Activities

3.4.1 Site Physical and Biological Characterization

This subtask includes three separate work activities:

- Surficial geologic/hydrologic investigation;
- Ecological evaluation; and,
- Collection of additional information on site physical characteristics and demographics.

3.4.1.1 Surficial Geologic Investigation

A surficial geologic investigation will be performed to define surficial geology, current drainage patterns, site geomorphology, site cultural features, and to evaluate landfill settlement.

The surficial geologic/investigation will entail the following field tasks:

- *Surficial Geologic Mapping* to identify soil conditions, bedrock outcrops, stratigraphic relationships, local landforms, and surface water bodies (including seeps). This effort will result in the development of a detailed geologic map of the site. Additionally, this will allow any seeps, if identified, to be sampled (as described in Section 6.3.8.1); and,

- *Landfill Settlement Evaluation* to review historical aerial photographs to determine the rate of landfill settlement for the inactive landfill.

3.4.1.2 Ecological Evaluation

The Scope of Work (SOW) for OU-2 requires performance of an ecological evaluation to evaluate the flora and fauna of the site, identify critical habitats and endangered species, and describe the ecological setting of the site and the surrounding area. The SOW for OU-1 requires a similar ecological evaluation. Following completion of the ecological evaluation by McLaren/Hart for OU-1, the data will be reviewed to determine if this evaluation is sufficient to meet the AOC requirements for OU-2. If the OU-1 ecological evaluation is determined to be insufficient, supplemental activities will be performed to address the outstanding issues.

3.4.1.3 Site Physical Characteristics and Demographic Investigation

As part of the initial RI activities, additional information will be obtained to assist in characterization of the site. This activity will include a literature review and field verification of information as required. The data collection activities will focus on updating geologic, hydrogeologic, hydrologic, ecologic, climatic, land use and demographic information for the site and surrounding area. This activity will provide a more complete database for the physical and demographic description of the site, and will assist in refining the Conceptual Site Model.

3.4.2 Hydrogeologic Characterization

3.4.2.1 Investigation Rationale

Groundwater beneath the site exists in alluvial deposits and bedrock. In the western portion of the site, saturated alluvium overlies the bedrock. Bedrock is the uppermost saturated unit in the eastern portion of the site. Previous hydrogeologic investigations have focused primarily on alluvial groundwater conditions, but have not yielded complete information regarding horizontal flow directions, vertical hydraulic gradients or groundwater velocity. In addition, previous groundwater investigations have not fully addressed hydrogeologic conditions in the bedrock. Data from previous investigations suggest that the regional groundwater flow is northwesterly towards the Missouri River. Modification of the local topography from quarrying and landfilling may have impacted surface water drainage and pre-existing groundwater recharge areas, which has likely impacted local groundwater flow conditions in the alluvial and upper bedrock aquifers. For example, leachate collection in the active landfill is designed to maintain a gradient into the landfill from the surrounding bedrock. The current network of monitoring wells is not sufficient to adequately determine local groundwater flow direction.

During the RI, the hydrogeologic framework beneath the site will be characterized by installing piezometers in the alluvial and bedrock aquifers. Aquifer permeability characteristics will be determined by conducting packer tests and slug tests. Horizontal flow directions and vertical hydraulic gradients will be identified by water level measurements in proposed piezometers and selected existing monitoring wells. The integrity of existing groundwater monitoring wells will be determined by an OU-1 well survey; only those determined to be reliable will be incorporated into the OU-2 hydrogeologic characterization.

The hydrogeologic investigation will also define the physical characteristics of the alluvial and bedrock aquifers beneath the site. Specifically, the drilling program will allow for accurate characterization of stratigraphic units including features such as facies changes, bedrock topography, geologic structural features and hydraulic properties of these units.

As discussed in Section 2.2.2 of the Work Plan, the site is situated on the edge of an alluvial valley formed by the Missouri River. The eastern portion of the site is underlain by a bedrock stratigraphic sequence consisting of the Salem/St. Louis Limestone, the Warsaw Shale, and the

Keokuk Formation. In the western portion of the site, these formations are overlain by a layer of alluvium ranging between 0 and 100 feet thick.

3.4.2.2 Piezometer Rationale

A series of clustered piezometers will be installed to evaluate groundwater flow directions in each stratigraphic unit to determine physical characteristics and hydraulic relationships. The piezometers will allow for characterization of hydrogeologic conditions of the critical water bearing zones. Based on current knowledge of the general hydrogeologic regime at the site, it is anticipated that the shallow piezometers at each cluster east of the alluvial valley will be screened at the top of the limestone aquifer, the middle piezometers will be screened at the bottom of the limestone aquifer (immediately above the Warsaw Shale), and the deep piezometers will be screened below the upper shale zone of the Warsaw Shale.

The piezometers to be installed during the RI will be designated "100-," "200-," and "300-" series. The "100-" and "200-" series piezometers will characterize the bedrock (Salem/St. Louis, Warsaw, and Keokuk Formations, if encountered) and the alluvium across the eastern part of the site. The "300-" series piezometers will characterize the bedrock (Salem/St. Louis Formation) and the alluvium across the western and southern parts of the site.

For clusters in the alluvial valley, it is anticipated that the shallow alluvium piezometers will be screened at the water table and the deep alluvium piezometers may be screened immediately above the limestone bedrock. The shallow bedrock piezometers will be screened approximately 50 feet into the limestone aquifer, the middle bedrock piezometers will be screened at the bottom of the limestone aquifer, and the deep bedrock piezometers will be screened below the Warsaw Shale. Additional alluvial piezometers are intended to characterize upper, intermediate, and lower zones previously identified within the alluvium. Table 3-2 lists the proposed piezometers, the corresponding aquifer to be monitored, and estimated depth of the piezometers.

Piezometers will be labeled with a prefix "PZ" and will include a suffix designation specific to the formation being monitored. An "A" suffix will be used if the piezometer is completed into the alluvium. An "S" suffix will be used if the piezometer is completed into the Salem/St. Louis Limestone. A suffix "K" will be used if the piezometer is completed into the Keokuk Limestone. An additional suffix will designate whether the piezometer is completed into the shallow (i.e., "S"), intermediate (i.e., "I"), or deep (i.e., "D") portion of the aquifer.

The following is an example of a piezometer designation: PZ-100-SS

Where:

PZ = piezometer;

100 = "100-series";

The first S = completed into the Salem/St. Louis formation; and,

The second S = completed into the upper shallow portion of the aquifer.

Four borings will be completed into the limestone sequence below the Warsaw Shale (assumed to be Keokuk Formation), 4 borings will be completed at the bottom of the Salem/St. Louis Limestone, and 23 borings will be completed at the top of the Salem/St. Louis Limestone. Sixteen borings will be drilled in the alluvium, of which ten will be completed at the water table, four will be completed in the intermediate portion of the aquifer, and two will be completed at the bottom of the aquifer.

If adverse conditions limit the application of hollow or solid stem augers, an alternative drilling method may be employed. Selection of alternative drilling methods will depend on field conditions, but may include advancing of casing and use of water rotary methods. Drilling will be conducted in a manner that minimizes the potential for cross contamination between aquifers. Depending on field conditions, temporary or permanent casings, designed to prevent potential cross-contamination of alluvial and bedrock ground water regimes, may be set in the upper intervals of the borehole. The casing will be grouted in-place with a cement-bentonite grout. The grout will be allowed to cure prior to recommencement of drilling.

3.4.2.3 Existing Monitoring Well Modification

The existing groundwater monitoring well 1201 will be modified and redesignated 1201-SS. This open hole completed well will be backfilled with grout, consistent with Missouri Well Construction Rules (MDNR, 1993), and a piezometer will be installed. The estimated depth of 1201-SS will be 145 feet.

3.4.2.4 Soil Sampling and Logging

Sampling of the alluvium will allow for direct observation of the overburden material at the site. Continuous sampling will allow the compilation of a continuous alluvial stratigraphic profile. In addition, sampling the alluvium will assist in determining piezometer screen intervals and allow for the proper sizing of the sand pack.

One sample from 12 of the boreholes will be analyzed for total organic carbon (TOC). TOC results will be used to assist in modeling potential migration of organic compounds in groundwater.

Single boreholes/piezometer locations will be continuously sampled. It is standard engineering practice to continuously sample the deeper boreholes in monitoring well pairs or clusters to obtain a continuous stratigraphic profile to the maximum depth of drilling. Duplicating sampling efforts for boreholes drilled directly adjacent to each other is unnecessary. Table 3-2 lists the proposed piezometers and identifies the piezometers which will be sampled continuously.

3.4.2.5 Bedrock Sampling and Logging

Bedrock characterization will be accomplished utilizing rock coring techniques. Coring will allow for precise stratigraphic control of the underlying bedrock and will define aquifer thickness and characteristics. Direct observation of the rock core samples allows identification of the geologic properties of the rock, such as fracture zones which may behave as preferred groundwater flow pathways. Core samples will allow for selection of packer test intervals and determination of screen intervals. Table 3-2 identifies the borings that will be cored.

3.4.2.6 Borehole Geophysics

Geophysical logging of the four deep (i.e., approximately 350 feet) bedrock borings targeted for the limestone sequence below the Warsaw Shale (assumed to be Keokuk Formation) will assist in the hydrogeologic characterization. A borehole geophysics program will be implemented at the four deepest rock boring clusters to provide supplemental hydrogeologic characterization data. The objectives of the borehole geophysical program will include correlation and definition of aquifer or other lithologic units, estimation of aquifer properties such as porosity and permeability, and an assessment of the physical properties associated with the materials surrounding the borehole.

The borehole geophysical methods for this investigation may include, as necessary, natural gamma ray, caliper, resistivity, neutron, and gamma-gamma density. It is anticipated that the borehole geophysics program will be conducted in open holes. Should field conditions require installing permanent or temporary casing, the borehole geophysics program will be limited to natural gamma ray.

3.4.2.7 Constant Head Injection Packer Testing

Constant head injection packer tests will be conducted in the four deep boring locations (PZ-100-KS, PZ-104-KS, PZ-106-KS, and PZ-111-KS) prior to piezometer installation in order to determine horizontal permeability of the bedrock aquifers. Packer test intervals will be chosen from visual observation of the bedrock core samples and from geophysical logs. Packer tests are anticipated to be conducted in both fractured and unfractured zones in the bedrock units, to provide an upper and lower limit of hydraulic conductivity.

3.4.2.8 Piezometer Development

Piezometers will be developed in order to ensure that drilling fluids and solids are removed, and to ensure hydraulic communication between the piezometer and the formation. All piezometers will be developed in accordance with the Missouri Well Construction Rule 10 CSR 23-4.070 and EPA guidance provided in *RCRA Ground-Water Monitoring: Draft Technical Guidance* (EPA, 1992).

3.4.2.9 Slug Tests in Piezometers

Slug tests will be conducted in all of the newly installed piezometers in order to evaluate the horizontal hydraulic conductivity of the formation adjacent to the screened interval.

3.4.2.10 Water Level Monitoring

Groundwater level measurements will be made subsequent to installation and development of the piezometers. In addition, groundwater levels will also be measured in existing wells identified as being suitable for groundwater monitoring purposes in the OU-1 RI/FS well integrity survey.

Fluid levels will be obtained in the leachate collection sumps, leachate wells, gas wells, and landfill gas collection manholes. Stream flow data, precipitation data, and surface water level data will be analyzed in conjunction with the water level data. These data will be used to aid in the definition of the groundwater regime at the site.

3.4.2.11 Groundwater Quality Sampling

It is anticipated that the OU-2 groundwater monitoring network will be comprised of selected existing site wells and new monitoring wells installed for the OU-1 RI, as well as selected piezometers from the hydrogeologic investigation for OU-2. The selection of monitoring wells will be based on a detailed review of the site hydrogeologic conditions, including:

- Horizontal and vertical flow directions;
- Horizontal and vertical hydraulic gradients;
- Aquifer and aquitard permeabilities; and,
- Relationship of monitoring points to potential sources of contamination.

A site conceptual model that clearly defines the flow patterns at the site will be developed from the hydrogeologic investigation. Potential sources of contaminant migration in groundwater will be identified, and appropriate monitoring wells will be selected to provide relevant chemical data. EPA will be afforded the opportunity to review the proposed monitoring well network prior to collection of groundwater samples in order to provide the EPA with the opportunity to comment. A detailed description of the proposed monitoring network will be provided in a technical memorandum. The memorandum will include rationale for the monitoring points selected and a map depicting the proposed network.

The proposed groundwater quality monitoring network will be designed to provide sufficient data to establish groundwater quality in the principal stratigraphic units at background locations as well as areas located downgradient of the identified source areas on-site. The results of the hydrogeologic investigation and the groundwater monitoring program will be evaluated to determine potential chemical migration pathways in the principal stratigraphic units and the potential for leachate from the identified source areas to have impacted groundwater quality in the site vicinity. This evaluation will also evaluate the potential for groundwater quality impacts to affect surface water bodies.

Once the final groundwater monitoring network is installed and the wells are developed, two rounds of groundwater sampling will be conducted. Groundwater samples from the first sampling round will be submitted to the project laboratory, as described in Section 4.0. Following evaluation of the first round data, a site-specific parameter list will be developed and proposed to the EPA for the second round of groundwater sampling.

3.4.3 Source Characterization

3.4.3.1 Investigation Rationale

As discussed in Sections 2 and 4 of the Work Plan, industrial wastes may have been disposed of at the site. The investigative activities will focus on characterization of the nature and extent of these potential sources of contamination at the site. Because the presumptive remedy at the site will include a landfill cap (at a minimum), the scope of the source area investigation can be targeted to obtain data necessary for the conceptual side model and predesign of the cap. Landfill gas and leachate collection may also be included in the presumptive remedy. To accomplish these goals the following field activities will be undertaken:

- Leachate sampling and analysis;

- Landfill gas characterization;

- Investigation of potential petroleum impacts near well MW-F2; and,
- Evaluation of potential impacts to surface water.

The following discussion provides a summary description of the field activities that will be performed for each task.

3.4.3.2 Leachate Sampling and Analysis

In order to determine whether past disposal practices may have resulted in source areas for contamination in the inactive landfill, a subsurface investigation will be performed consisting of the installation of leachate risers in the inactive landfill. Based on the potential source areas identified from historical records, six leachate risers will be installed. The risers will be sampled if leachate is present. Following is a description of the rationale for each of the leachate risers. Leachate riser locations are identified in Section 4.2.1.

The leachate risers will be designated LR-100 through LR-105. Leachate risers LR-100 through LR-102 will be installed in potential source areas in the inactive landfill on the western portion of the site. Leachate risers LR-103 and LR-104 will be installed east of the inactive landfill in the central portion of the site in two potential source areas. Leachate riser LR-105 will be installed near the berm of the inactive landfill at the western portion of the site in conjunction with the investigation of potential petroleum impacts near well MW-F2.

3.4.4 Landfill Gas Characterization

A field investigation will be conducted to determine the extent and magnitude of landfill gas emissions across the inactive landfill areas. This investigation will consist of two components:

- ▷ An investigation of landfill gas emissions along the crest of the inactive landfill areas, biased toward the proposed leachate riser locations; and,
- ▷ An investigation of potential landfill gas migration along the western boundary of the inactive landfill.

Both investigation methodologies are described below.

3.4.4.1 Inactive Landfill Investigation

A soil gas survey will be conducted at ten locations within the boundary of the inactive landfill areas. The location of these soil gas sampling points will be biased toward the source areas targeted by the leachate risers and the crest of the landfill. These sampling points will be driven to a depth of approximately 3 feet below ground surface using standard soil gas sampling techniques as described in Section 6.3.6.2. The gas samples will be submitted for laboratory analysis of landfill gas parameters as described in Section 4.2.3. The sampling points will be abandoned by backfilling the annulus with bentonite. The results from this investigation will provide a preliminary indication of landfill gas chemistry and will provide data for the conceptual site model.

3.4.4.2 Boundary Investigation

Landfill gas has the potential to migrate along the western side of the inactive landfill near St. Charles Rock Road. A soil gas survey will be conducted along the access road on the west side of the inactive landfill to determine whether gas migration may be occurring. The soil gas survey is intended to provide qualitative information, using a combustible gas indicator to measure gas concentrations.

3.4.5 Petroleum Investigation

Previous investigations have shown that environmental media near monitoring well MW-F2 may have been impacted by petroleum products. A subsurface investigation will be conducted to determine the extent and magnitude of the impacts. The investigation will include the following components:

- Installation of piezometer PZ-303-AS;
- Completion of four borings to characterize soil impacts;
- Installation of leachate riser LR-105; and,
- Soil, leachate, and groundwater sampling.

3.4.6 Surface Water, Seep, and Sediment Investigation

To determine the nature and extent of surface water, seep, and sediment contamination, if present, these matrices will be sampled. The following are the principal tasks and methods that will be used to complete this sampling program:

- Conduct a seep survey to determine the location of flowing seeps immediately after a rainfall event of at least 0.1-inch in 24 hours. Up to ten seep locations will be staked, photo-documented and assigned a unique sample location code (SP-01, etc.). Seep discharge at each of the defined seep locations will be estimated at the time of the sampling event. Samples collected from up to 10 seep locations will be sufficient to characterize seep quality. The seep survey will be conducted as part of the surficial geological survey described in Section 3.4.1.1;

- Collect one water sample and one sediment sample from each of the defined seep locations. These samples will be submitted to the project laboratory for analysis as described in Section 4.2.1; and,

- Collect one surface water and sediment sample from the Earth City Storm Water Retention Pond at a location identified as most subject to runoff impacts from the inactive landfill. A second surface water sediment sample will be collected from a background location south of the site, south of existing monitoring wells S-80, I-50, and D-91. These samples will be submitted to the project laboratory for chemical analysis as described in Section 4.2.1.

3.5 Rationale for FS Field Activities

A landfill cap investigation will be undertaken concurrent with the Remedial Investigation field program to obtain data that will be useful for evaluation of remedial alternatives during the Feasibility Study. The landfill cap investigation program will determine the inactive landfill existing cap thickness and its physical properties. The data collection program will be performed using a hand auger or back hoe to collect soil samples for geotechnical testing and allow for measurement of existing cap thickness. The investigative program will be conducted using a 200-foot grid spacing over the capped area of the inactive landfill. Data obtained from this investigation will be useful in establishing parameters for HELP modeling (i.e., potential leachate generation), as well as for development and evaluation of remedial alternatives for the site. Results of the HELP modeling will also be useful for the site Baseline Risk Assessment.

3.6 Air Quality Monitoring

To determine the potential for landfill gas to impact air quality, an air quality monitoring program will be undertaken as part of the RI field activities. As described in the Site Health and

Safety Plan (Appendix B of the Work Plan), air quality will be monitored and recorded at each investigative location and sampling point using a combustible gas indicator and an FID or PID. Data will be collected according to the frequencies specified in the Site Health and Safety Plan. Monitoring frequency varies according to the parameter monitored and concentrations detected.

The results from the air quality monitoring program will be evaluated on an ongoing basis to determine whether significant landfill gas concentrations are being observed during field work, and to determine the potential for adverse impact from landfill gas.

For example, air monitoring for volatile organic compounds will be conducted continuously when drilling near the landfilled areas, and monitoring for radionuclides will be conducted for samples and equipment when drilling near OU-1.

TABLE 3-1

REMEDIAL INVESTIGATION TASK
DATA QUALITY NEEDS AND OBJECTIVES

Task/Subtask	Data Application	Analytical Level	QA/QC Samples	Objectives	Chemicals of Concern	Required Detection Levels
SITE PHYSICAL AND BIOLOGICAL CHARACTERIZATION						
Surficial Geologic Investigation	Site Characterization	NA	NA	Identify site features to define potential transport pathways and human and ecological receptor populations.	NA	NA
Ecological Evaluation	Site Characterization Risk Assessment	NA	NA	Provide an understanding of the site and vicinity ecological setting, including flora and fauna, critical habitats, and endangered species.	NA	NA
Physical Characteristics and Demographics	Site Characterization Risk Assessment	NA	NA	Provide an understanding of land use and population in the vicinity of the site.	NA	NA
SITE HYDROGEOLOGICAL CHARACTERIZATION						
Well Integrity Evaluation	Site Characterization Risk Assessment	NA	NA	Identify existing wells which may be suitable for hydrogeologic characterization and/or water quality testing.	NA	NA
Hydrogeologic Investigation						
▸ Aquifer Testing	Site Characterization Remedial Design	Level II	None	Determine aquifer characteristics such as vertical and horizontal flow gradients, flow rates, aquifer thickness, and permeability.	NA	Instrument Sensitivity

Footnotes provided on page 3

TABLE 3-1

REMEDIAL INVESTIGATION TASK
DATA QUALITY NEEDS AND OBJECTIVES

Task/Subtask	Data Application	Analytical Level	QA/QC Samples	Objectives	Chemicals of Concern	Required Detection Levels
SITE HYDROGEOLOGICAL CHARACTERIZATION continued						
▸ Subsurface Soil Sampling and Analysis	Site Characterization Remedial Design	Level III	Field Duplicate Rinsate Blank Trip Blank	Assist in determining chemical compound transport in groundwater.	TOC	Method Detection Limits
▸ Geotechnical Sampling and Analysis	Site Characterization Remedial Design	Level II	NA	Determine structural integrity of landfill cover.	NA	Instrument Sensitivity
▸ Groundwater Sampling and Analysis	Site Characterization Remedial Design Risk Assessment	Level III	Background Field Duplicate Rinsate Blank Trip Blank	Identify nature and extent of groundwater impacts. Determine need for groundwater remediation.	VOCs, SVOCs, pesticides, PCBs metals, cyanide, TPH, radionuclides*	Risk-based detection limits
SOURCE CHARACTERIZATION						
Leachate Sampling and Analysis	Source Characterization Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank	Characterize leachate.	VOCs, SVOCs, pesticides, PCBs metals, cyanide, TPH,*	Method detection limits
Landfill Gas Sampling and Analysis	Source Characterization Remedial Design Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank	Characterize Landfill Gas.	VOCs*, methane	Risk-based detection limits
Hydrocarbon Investigation Near MW-F2						
▸ Subsurface Soil, Leachate, and Groundwater Sampling and Analysis	Source Characterization Remedial Design Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank	Characterize extent of hydrocarbon impacts near MW-F2.	BTEX, TPH	Method detection limits

Footnotes provided on page 3

TABLE 3-1

REMEDIAL INVESTIGATION TASK
DATA QUALITY NEEDS AND OBJECTIVES

Task/Subtask	Data Application	Analytical Level	QA/QC Samples	Objectives	Chemicals of Concern	Required Detection Levels
SITE HYDROLOGIC CHARACTERIZATION						
▸ Surface Water Sampling and Analysis	Site Characterization Remedial Design Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank	Characterize surface water, determine need for remediation.	VOCs, SVOCs, pesticides, PCBs metals, cyanide, TPH*	Method detection limits
▸ Seep Survey, Sampling, and Analysis	Site Characterization Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank	Characterize seeps.	VOCs, SVOCs, pesticides, PCBs metals, cyanide, TPH*	Method detection limits
SITE AIR QUALITY CHARACTERIZATION						
Air Quality Monitoring	Site Characterization Remedial Design Risk Assessment Health and Safety	Level I	None	Determine impacts to ambient air quality from landfill gas, monitor for health and safety purposes.	VOCs, O_2, methane	Instrument Sensitivity

* For specific analytes, see Tables 4-2 through 4-6.
NA = Not applicable
TOC = Total Organic Carbon
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PCB = Polychlorinated biphenyl
TPH = Total petroleum hydrocarbon
BTEX = Benzene, toluene, ethylbenzene, xylenes

TABLE 3-2

PIEZOMETER RATIONALE

PZ-100-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. PZ-100-SS is intended to be used in conjunction with PZ-115-SS and PZ-208-SS in triangulation of water levels along the northern end of the sanitary landfill.
PZ-100-SD	Boring intended to be completed in the lower portion of the Salem/St. Louis Limestone. PZ-100-SD will be used in conjunction with PZ-100-SS and PZ-100-KS to determine vertical gradients along the northern end of the sanitary landfill.
PZ-100-KS	Boring intended to be completed into the limestone sequence below the shales of the Warsaw Shale (assumed to be Keokuk Formation). This boring will be continuously sampled during drilling and will be geophysically logged upon reaching total depth. PZ-100-KS will be used in conjunction with PZ-100-SS and PZ-100-SD to determine vertical gradients along the northern end of the sanitary landfill.
PZ-101-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-101-SS is intended to be used in conjunction with PZ-102-SS and PZ-200-SS in triangulation of water levels along the northeastern portion of the sanitary landfill.
PZ-102-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-102-SS is intended to be used in conjunction with PZ-101-SS and PZ-200-SS in triangulation of water levels along the northeastern portion of the sanitary landfill.
PZ-103-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-103-SS is intended to be used in conjunction with PZ-201-SS and PZ-202-SS in triangulation of water levels along the eastern portion of the sanitary landfill.
PZ-104-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. PZ-104-SS is intended to be used in conjunction with PZ-105-SS and PZ-203-SS in triangulation of water levels along the southeastern portion of the sanitary landfill.
PZ-104-SD	Boring intended to be completed in the lower portion of the Salem/St. Louis Limestone. PZ-104-SD will be used in conjunction with PZ-104-SS and PZ-104-KS to determine vertical gradients along the southeastern edge of the sanitary landfill.
PZ-104-KS	Boring intended to be completed into the limestone sequence below the shales of the Warsaw Shale (assumed to be Keokuk Formation). This boring will be continuously sampled during drilling and will be geophysically logged upon reaching total depth. PZ-104-KS will be used in conjunction with PZ-104-SS and PZ-104-SD to determine vertical gradients along the southeastern end of the sanitary landfill.

TABLE 3-2

PIEZOMETER RATIONALE

PZ-105-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-105-SS is intended to be used in conjunction with PZ-106-SS, PZ-204-SS and LCS-2 in triangulation of water levels near the active landfill.
PZ-106-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. PZ-106-SS is intended to be used in conjunction with PZ-105-SS, PZ-204-SS, and LCS-2 in triangulation of water levels near the active landfill.
PZ-106-SD	Boring intended to be completed in the lower portion of the Salem/St. Louis Limestone. PZ-106-SD will be used in conjunction with PZ-106-SS and PZ-106-KS to determine vertical gradients along the southern edge of the sanitary landfill.
PZ-106-KS	Boring intended to be completed 150 feet below the top of the Warsaw Shale (assumed to be into the Keokuk Formation). This boring will be continuously sampled during drilling and will be geophysically logged upon reaching total depth. PZ-106-KS will be used in conjunction with PZ-106-SS and PZ-106-SD to determine vertical gradients along the southern end of the sanitary landfill.
PZ-107-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-107-SS will be used in conjunction with PZ-106-SS, LCS-4, and PZ-205-SS in triangulation of water levels near the southwestern corner of the sanitary landfill.
PZ-108-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-108-SS is intended to be used in conjunction with PZ-109-SS and PZ-206-SS in triangulation of water levels near the old quarry.
PZ-109-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-109-SS is intended to be used in conjunction with PZ-108-SS and PZ-206-SS in triangulation of water levels near the old quarry.
PZ-110-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. The location of PZ-110-SS was selected to maintain an approximate 400 lineal foot spacing and to assist in defining the location of the edge of the alluvial valley.
PZ-111-SD	Boring intended to be completed in the lower portion of the Salem/St. Louis Limestone. No shallow boring is necessary at this cluster location because wells MW-F1S and MW-F1D already exist. PZ-111-SD will be used in conjunction with MW-F1S, MW-F1D, and PZ-111-K to determine vertical gradients along the western edge of the sanitary landfill.

TABLE 3-2

PIEZOMETER RATIONALE

PZ-111-KS	Boring intended to be completed into the limestone sequence below the shales of the Warsaw Shale (assumed to be Keokuk Formation). This boring will be continuously sampled during drilling and will be geophysically logged upon reaching total depth. PZ-111-KS will be used in conjunction with PZ-106-SD, MW-F1S, and MW-F1D to determine vertical gradients along the western edge of the sanitary landfill.
PZ-112-AS	Shallow boring intended to be completed 10 feet below the water table in the alluvium. This boring will be continuously sampled during drilling. Alluvial boring intended to determine the potentiometric surface between the inactive landfill to the west and the sanitary landfill to the east.
PZ-113-AS	Shallow boring intended to be completed 10 feet below the water table in the alluvium. PZ-113-AS is intended to be used in conjunction with PZ-207-AS and S-84 in triangulation of water levels between the demolition landfill and the sanitary landfill.
PZ-113-AD	Boring intended to be completed at the base of the alluvium. PZ-113-AD will be used in conjunction with PZ-113-AS to determine vertical gradients between the demolition landfill and the sanitary landfill.
PZ-113-SS	Boring intended to be completed 50 feet into the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-113-SS will be used in conjunction with PZ-113-AS and PZ-113-AD to determine vertical gradients between the demolition landfill and the sanitary landfill.
PZ-114-AS	Shallow boring intended to be completed 10 feet below the water table in the alluvium. This boring will be continuously sampled during drilling. PZ-114-AS is intended to provide potentiometric surface data north of the sanitary landfill.
PZ-115-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-115-SS is intended to be used in conjunction with PZ-100-SS and PZ-208-SS in triangulation of water levels along the northern end of the sanitary landfill.
PZ-200-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-200-SS is intended to be used in conjunction with PZ-101-SS and PZ-102-SS in triangulation of water levels along the northeastern portion of the sanitary landfill. PZ-200-SS will also be used to determine landfill gas concentrations.
PZ-201-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-201-SS is intended to be used in conjunction with PZ-103-SS and PZ-202-SS in triangulation of water levels along the eastern portion of the sanitary landfill. PZ-201-SS will also be used to determine landfill gas concentrations.

TABLE 3-2

PIEZOMETER RATIONALE

PZ-202-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-202-SS is intended to be used in conjunction with PZ-103-SS and PZ-201-SS in triangulation of water levels along the eastern portion of the sanitary landfill. PZ-202-SS will also be used to determine landfill gas concentrations.
PZ-203-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-203-SS is intended to be used in conjunction with PZ-104-SS and PZ-105-SS in triangulation of water levels along the southeastern portion of the sanitary landfill. PZ-203-SS will also be used to determine landfill gas concentrations.
PZ-204-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-204-SS is intended to be used in conjunction with PZ-105-SS, PZ-106-SS and LCS-2 in triangulation of water levels near the active landfill.
PZ-205-AS	Shallow boring intended to be completed 10 feet below the water table in the alluvium. PZ-205-AS will be used in conjunction with PZ-205-SS to determine vertical gradients near the southwestern corner of the sanitary landfill.
PZ-205-SS	Deep boring intended to be completed 50 feet into the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-205-SS will be used in conjunction with PZ-106-SS, PZ-107-SS, and LCS-4 in triangulation of water levels near the southwestern corner of the sanitary landfill.
PZ-206-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-206-SS is intended to be used in conjunction with PZ-108-SS and PZ-109-SS in triangulation of water levels near the old quarry.
PZ-207-AS	Shallow boring intended to be completed 10 feet below the water table in the alluvium. This boring will be continuously sampled during drilling. PZ-207-AS is intended to define the hydrogeologic conditions between the demolition landfill and the sanitary landfill as well as to allow triangulation of water levels between the two landfills in conjunction with PZ-113-AS and S-84.
PZ-208-SS	Shallow boring intended to be completed 10 feet below the water table in the Salem/St. Louis Limestone. This boring will be continuously sampled during drilling. PZ-208-SS is intended to be used in conjunction with PZ-100-SS and PZ-115-SS in triangulation of water levels along the northern end of the sanitary landfill.

TABLE 3-2

PIEZOMETER RATIONALE

PZ-300-AS,AI,AD	One cluster of wells will be installed near the southern edge of the site, adjacent to wells D-91, I-50, and S-80. This cluster will provide background groundwater quality data.
PZ-300-SS	One upper bedrock piezometer will be installed near wells D-91, I-50, and S-80 to provide vertical gradient information between the alluvium and the bedrock in this background setting.
PZ-301-SS	One upper bedrock piezometer will be installed near the southern edge of the soil borrow area. This piezometer will provide supplemental background data for the upper and lower Salem/St. Louis Formation, respectively.
PZ-302-AS,AI	One cluster of piezometers will be installed near well S-75. This cluster will provide hydraulic head data immediately upgradient of the landfilled materials.
PZ-303-AS	This piezometer will be installed adjacent to MW-F2, which has exhibited petroleum odors. The shallow completion interval coincides with the shallow completion interval for MW-F2.
PZ-304-AS,AI	A cluster of piezometers will be installed along the western boundary of the site, near abandoned well I-56. This cluster will be used to determine the hydraulic head near the Earth City stormwater retention feature, to compare water levels to leachate levels within the landfilled materials, and to determine vertical gradients at the edge of the facility.
PZ-305-AS,AI	A cluster of wells will be installed near the center of the site in an area identified as an underground storage tank (UST) site. This cluster will be used to triangulate water levels across the western portion of the site.

4.0 SAMPLE LOCATION AND FREQUENCY

4.1 Introduction

This section identifies the sample locations and frequency for chemical and physical tests to be performed as part of the OU-2 RI/FS. As previously discussed, aqueous, solid, and gaseous samples from various matrices will be collected and subjected to chemical analysis. Additionally, physical analyses will be performed on aquifer materials and soil samples, and water level monitoring will be conducted. The type and frequency of these analyses are identified in the following subsections.

4.2 Chemical Analysis

Environmental samples collected as part of the RI will be analyzed for a variety of parameters, depending upon task data quality needs and objectives (Table 3-1). Analytical results will be used for risk assessment and site characterization purposes. The parameter lists developed for risk assessment purposes are based on RCRA Subtitle D Appendix I parameters, target compound list (TCL) semi-volatiles, and TCL pesticides and polychlorinated biphenyls, plus additional site-specific parameters. The proposed detection limits for these parameters have been determined based on extensive review of maximum concentration limits (MCLs), maximum concentration limit goals (MCLGs), and EPA Region III risk-based concentration (RBC) tables (EPA, 1994a). The RBC tables are accepted by other EPA regions as appropriate detection limits for these compounds. The proposed detection limits are identified as health-based criteria. The analytical methods used will be determined by the actual concentrations detected and the appropriate health-based criteria. Actual analytical methods used will be identified in an addendum to the QAPP.

4.2.1 Aqueous Samples

Aqueous samples will be collected from groundwater, surface water, seeps, and leachate sources. All aqueous samples will be subjected to certain laboratory quality assurance/quality control (QA/QC) procedures, as described in Section 4.2.4. The following paragraphs identify sample location and frequency requirements for each media. Sample frequencies and QA/QC requirements for aqueous samples are also listed in Table 4-1.

Groundwater

The EPA will be provided with a technical memorandum describing the proposed monitoring network. The memorandum will include a rationale for the selected monitoring point, and a map depicting the network. Groundwater samples will be analyzed for the parameter identified in Tables 4-2 and 4-3.

Surface Water

Two surface water samples will be collected, one from the Earth City Storm Water Retention Pond and one from a background stormwater retention pond south of existing wells; there will be one round of surface water sampling. The samples will be collected from the locations identified in Figure 4-3. The surface water samples will be subjected to Level III laboratory chemical analysis for the constituents identified in Table 4-2.

Seeps

Seep samples will be collected from seeps identified during the surficial geologic survey. The number of seep samples to be collected will be determined following identification of seep locations. Up to ten seep samples will be collected. One round of seep sampling will be conducted. Seep samples will be subjected to Level III laboratory chemical analysis for the constituents identified in Table 4-2.

Leachate

Leachate samples will be collected from the six leachate risers installed in the inactive landfill area (Figure 4-4) if leachate is encountered. One round of leachate sampling will be conducted. Leachate samples will be subjected to Level III laboratory chemical analysis for the constituents identified in Table 4-2.

4.2.2 Solid Samples

Samples of solids for chemical analysis will be collected from sediments in two nearby surface water bodies, from piezometer borings, and from soil borings near MW-F2, as described below.

Sediment Sample

Two sediment samples for chemical analysis will be collected from Earth City Stormwater Retention Ponds. The samples will be collected from the same location as the surface water samples (Figure 4-3), and will be subjected to Level III laboratory chemical analysis for the constituents identified in Table 4-4.

Soil Samples

One soil sample from the screened interval in each of the 12 "300" series piezometers will be collected and subjected to Level II laboratory chemical analysis for total organic carbon (TOC).

Soil samples will be collected from four soil borings installed near MW-F2 as part of a petroleum impact investigation (Figure 4-4). One soil sample from each boring will be subjected to Level III laboratory chemical analysis for the constituents identified in Table 4-5. The sample submitted for laboratory analysis will be determined by field headspace analysis; the sample exhibiting the highest headspace reading from each borehole will be submitted. If no sample exhibits headspace readings above background levels, one randomly-selected sample from each borehole will be submitted.

4.2.3 Gaseous Samples

Gaseous samples will be collected from landfill gas and ambient air sources, as described below.

Landfill Gas

Landfill gas samples will be collected from ten temporary landfill gas probes installed along the crest of the inactive landfill and from ten temporary landfill gas probes installed along the western boundary of the inactive landfill (Figure 4-5). The 20 probes will be subjected to Level I field analysis for volatile organic compounds, combustible gases, and hydrogen sulfide. There will be one round of landfill gas sampling. Samples for Level III laboratory chemical analysis will be collected from the ten probes at the crest of the inactive landfill. Level III analysis will be conducted for the constituents identified in Table 4-6.

Ambient Air

Level I and/or Level II field chemical analysis of ambient air will be conducted during all environmental media sample collection activities, as required by the Site Health and Safety Plan (Appendix B of the Work Plan). Ambient air monitoring will include, at a minimum, VOC monitoring with a PID. At sample locations with a potential for landfill gas impacts (such as leachate risers), ambient air will also be monitored for combustible gases and hydrogen sulfide.

4.2.4 Quality Assurance/Quality Control Samples

During each round of sampling for laboratory chemical analyses, Quality Assurance/Quality Control (QA/QC) samples will be included with the investigative samples. The types of QA/QC samples and their frequencies are as follows.

> Trip Blank - A water sample prepared by the laboratory that is transported to the sampling site and handled in the same manner as other samples, except that it remains unopened, and then is returned to the laboratory for VOC analysis to determine QA/QC of sample handling procedures. One trip blank will be included in each cooler containing aqueous or gas samples. The frequency of analysis will be one trip blank for every ten VOC samples.

> Equipment Blank - A laboratory-prepared sample of Type I reagent grade water that is routed through decontaminated sampling equipment in a manner identical to the collection of actual investigative samples to assess the effectiveness of decontamination procedures. A minimum of one equipment blank will be taken for each sampling event, or for every ten or fewer groundwater samples, whichever is less.

Field Blank - A laboratory-prepared sample of Type I reagent grade water that is poured directly from the laboratory container into a sample bottle during the field program. The field blank will provide information on the potential for site air quality to affect VOC analyses. For landfill gas analyses, a field blank consists of a sampling container filled with ambient air. A minimum of one field blank will be taken for each sampling event, or for every ten or fewer groundwater, surface water, or landfill gas samples, whichever is more frequent.

Duplicate - A duplicate sample taken in the field and sent to the laboratory for analysis. The results will provide some indication of the homogeneity of the sample medium and the precision of the laboratory and its equipment. A minimum of one field duplicate will be collected for each sampling event, or for each ten or fewer samples for landfill gas and groundwater, whichever is more frequent. Field duplicates will only be collected for VOC analyses of soil/sediment matrices.

A summary of the minimum number of investigative and QA/QC samples that will be collected for each anticipated sampling round for each medium is presented in Table 4-1.

4.3 Physical Analyses

4.3.1 Aquifer Testing

Packer tests and slug tests will be performed in selected boreholes and piezometers, at the locations and frequencies identified in the following paragraphs.

Packer Tests

Packer tests will be conducted in four deep boreholes (Figure 4-2) prior to piezometer installation. Packer tests will be conducted at various locations in each borehole, to identify a range of formation hydraulic conductivity. It is estimated that at least six packer tests will be performed in each of the four deep boreholes.

Slug Tests

Slug tests will be performed in the 47 newly-installed piezometers (Figure 4-2). One round of slug tests (rising or falling head) will be performed at each location.

4.3.2 Soil Physical Analysis

Soil samples collected from piezometer boreholes drilled as part of this RI and from selected inactive landfill cap investigation boreholes will be subjected to geotechnical analyses, as described below.

Piezometer Borehole Samples

Selected soil samples collected from new piezometer boreholes drilled as part of this RI (Figure 4-2) will be subjected to geotechnical analysis by the ASTM tests identified in Table 4-7. The estimated number of samples for each test is also provided in Table 4-7.

Inactive Landfill Cap Borehole Samples

Boreholes will be collected at the node points of a 200-foot grid on the inactive landfill (Figure 4-6); samples will be collected from each borehole where the landfill cap is at least 1.5 feet thick. Approximately 20 percent of the samples collected will be subjected to the ASTM tests listed in Table 4-7.

4.3.3 Water Level Monitoring

Water level monitoring will be conducted for groundwater, surface water, and leachate, as described in the following paragraphs.

Groundwater Level Monitoring

Groundwater level monitoring will be conducted in the newly-installed piezometers (Figure 4-2), and existing wells identified during the OU-1 well integrity survey (Figure 4-1). It is estimated that 55 groundwater level monitoring locations will be utilized. Groundwater level monitoring will be conducted on a monthly basis for a minimum of 12 months. Additional groundwater level measurement will be conducted during groundwater sample collection activities.

Surface Water Level Monitoring

Surface water levels in the Earth City Storm Water Retention Ponds will be monitored. The surface water level monitoring will be performed when the surface water and sediment sample are collected from the ponds, and on a monthly basis for a minimum of 12 months (concurrent with groundwater level monitoring).

Leachate Level Monitoring

Leachate level monitoring will be conducted in the existing leachate collection sumps, as well as the leachate risers to be installed as part of the OU-2 RI/FS. Leachate level monitoring will be conducted concurrently with the groundwater level monitoring described above (i.e., monthly for a minimum of 12 months). Additional leachate level measurement will likely be conducted during leachate sampling activities.

TABLE 4-1

ESTIMATED NUMBER OF INVESTIGATIVE AND QA/QC SAMPLES

SAMPLE MEDIA	NUMBER OF INVESTIGATIVE SAMPLES	NUMBER OF EQUIPMENT RINSATES	NUMBER OF FIELD DUPLICATES
Groundwater			
- Round 1	Reserved**	Reserved*	Reserved
- Round 2	Reserved	Reserved*	Reserved
Surface Water			
- Seeps	As necessary	1 per 10 or fewer investigative samples	1 per 10 or fewer investigative samples
- Earth City Storm Water Retention Ponds***	2	1	1
Sediment			
- Seeps	As necessary	1 per 10 or fewer investigative samples	1 per 10 or fewer investigative samples
- Earth City Storm Water Retention Ponds***	2	1	1
Leachate	6		1
Landfill Gas	20	2	2
Soil Gas	4	1	1
Subsurface Soil (TOC)	24	0	0

* If dedicated or disposable sampling equipment is used for groundwater sampling, no equipment rinsates will be collected.

** The number of groundwater investigative samples will be determined based on hydrogeologic characterization data. The wells to be sampled will be selected and communicated to the EPA in a monthly report or technical memorandum for EPA's approval.

*** Includes one background sample.

TABLE 4-2

AQUEOUS SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1] Groundwater	HEALTH-BASED CRITERIA[2] Limit	Unit
RCRA SUBTITLE D APPENDIX I METALS			
Antimony	7041	6	ug/l
Arsenic	7060	3.8	ug/l
Barium	6010	2000	ug/l
Beryllium	6010	1.6	ug/l
Nickel	6010	100	ug/l
Selenium	7740	50	ug/l
Silver	6010	180	ug/l
Sodium	6010	-	-
Thallium	7841	2	ug/l
Vanadium	6010	260	ug/l
Zinc	6010	5000	ug/l
CONVENTIONALS			
Ammonia as Nitrogen	350.1	-	-
Boron	6010	3300	ug/l
Cadmium	6010	5	ug/l
Calcium	6010	-	-
Chemical Oxygen Demand (COD)	410.4	-	-
Chloride	325.2	250	mg/l
Chromium	6010	100	ug/l
Cobalt	6010	6600	ug/l
Copper	6010	1000	ug/l
Cyanide, Total	9010	200	ug/l
Fluoride	340.2	-	-
Hardness, Total (Calculated)	130.2	-	-
Iron	6010	-	-
Lead	7421	-	-
Magnesium	6010	-	-
Manganese	6010	-	-
Mercury	7470	2	ug/l
Nitrate/Nitrite	353	10	mg/l
Phosphorus, Total	365.2	-	-
Sulfate as SO_4	375.4	250	mg/l
Sulfide	9030	-	-
Total Dissolved Solids (TDS)	160.1	500	mg/l
Total Organic Carbon (TOC)	415.1	-	-
Total Petroleum Hydrocarbons	8015M	-	-
FIELD MEASUREMENTS			
pH (Field)	150.1	-	-
Specific Conductance (Field)	120.1	-	-
Groundwater Elevation	Field	-	-
Temperature	Field	-	-
RCRA SUBTITLE D APPENDIX I VOLATILE ORGANIC COMPOUNDS			
Acetone	8260	3700.0	ug/l
Acrylonitrile	8260	12.0	ug/l
Benzene	8260	5.0	ug/l
Bromochloromethane	8260	-	-
Bromodichloromethane	8260	17.0	ug/l
Bromoform (Tribromomethane)	8260	100.0	ug/l
Bromomethane (Methyl bromide)	8260	8.7	ug/l
Carbon disulfide	8260	21.0	ug/l
Carbon tetrachloride	8260	5.0	ug/l
Chlorobenzene	8260	39.0	ug/l
Chloroethane	8260	8600.0	ug/l
Chloroform (Trichloromethane)	8260	15.0	ug/l
Chloromethane (Methyl chloride)	8260	140.0	ug/l
1,2-Dibromo-3-chloropropane	8260	4.8	ug/l
Dibromochloromethane	8260	13.0	ug/l
1,2-Dibromoethane (Ethylene dibromide)	8260	0.075	ug/l
trans-1,4-Dichloro-2-butene	8260	-	-

Footnotes provided on page 4

TABLE 4-2

AQUEOUS SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1] Groundwater	HEALTH-BASED CRITERIA[2] Limit	Unit
1,2-Dichlorobenzene (o-DCB)	8260	370.0	ug/l
1,4-Dichlorobenzene (p-DCB)	8260	44.0	ug/l
1,1-Dichloroethane	8260	810.0	ug/l
1,2-Dichloroethane	8260	5.0	ug/l
1,1-Dichloroethene	8260	4.4	ug/l
cis-1,2-Dichloroethene	8260	61.0	ug/l
trans-1,2-Dichloroethene	8260	100.0	ug/l
1,2-Dichloropropane	8260	5.0	ug/l
cis-1,3-Dichloropropene	8260	-	-
trans-1,3-Dichloropropene	8260	-	-
Ethylbenzene	8260	700.0	ug/l
2-Hexanone	8260	-	-
Methyl ethyl ketone (2-Butanone)	8260	22000.0	ug/l
Methyl iodide (Iodomethane)	8260	-	-
Methyl isobutyl ketone (4-Methyl-2-pentanone)	8260	2900.0	ug/l
Methylene bromide	8260	61.0	ug/l
Methylene chloride	8260	5.0	ug/l
Styrene	8260	100.0	ug/l
1,1,1,2-Tetrachloroethane	8260	41.0	ug/l
1,1,2,2-Tetrachloroethane	8260	5.2	ug/l
Tetrachloroethene	8260	5.0	ug/l
Toluene	8260	750.0	ug/l
1,1,1-Trichloroethane	8260	200.0	ug/l
1,1,2-Trichloroethane	8260	5.0	ug/l
Trichloroethene	8260	5.0	ug/l
Trichlorofluoromethane (Freon 11)	8260	1300.0	ug/l
1,2,3-Trichloropropane	8260	0.15	ug/l
Vinyl acetate	8260	37000.0	ug/l
Vinyl chloride	8260	1.9	ug/l
Xylenes	8260	10000.0	ug/l
TCL SEMIVOLATILE ORGANIC COMPOUNDS			
Acenaphthene	8270	2200.0	ug/l
Acenaphthylene	8270	-	-
Anthracene	8270	11000	ug/l
Benzo(a)anthracene	8270	9.2	ug/l
Benzo(a)pyrene	8270	0.2	ug/l
Benzo(b)fluoranthene	8270	9.2	ug/l
Benzo(ghi)perylene	8270	-	-
Benzo(k)fluoranthene	8270	92	ug/l
4-Bromophenyl phenyl ether	8270	2100	ug/l
Butyl benzyl phthalate	8270	7300	ug/l
Carbazole	8270	-	-
p-Chloro-m-cresol	8270	-	-
4-Chloroaniline	8270	150	ug/l
bis(2-Chloroethoxy)methane	8270	-	-
bis(2-Chloroethyl)ether	8270	0.92	ug/l
bis(2-Chloroisopropyl)ether	8270	96	ug/l
2-Chloronaphthalene	8270	2900	ug/l
2-Chlorophenol	8270	180	ug/l
4-Chlorophenyl phenyl ether	8270	-	-
Chrysene	8270	920	ug/l
m-Cresol	8270	1800	ug/l
o-Cresol	8270	1800	ug/l
p-Cresol	8270	180	ug/l
Dibenzo(a,h)anthracene	8270	0.92	ug/l
Dibenzofuran	8270	-	-
3,3'-Dichlorobenzidine	8270	15	ug/l
2,4-Dichlorophenol	8270	110	ug/l
Diethyl phthalate	8270	29000	ug/l
Dimethyl phthalate	8270	370000	ug/l
2,4-Dimethylphenol	8270	730	ug/l
Di-n-butyl phthalate	8270	3700	ug/l

Footnotes provided on page 4

TABLE 4-2

AQUEOUS SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1] Groundwater	HEALTH-BASED CRITERIA[2] Limit	Unit
4,6-Dinitro-o-cresol	8270	-	-
2,4-Dinitrophenol	8270	73	ug/l
2,4-Dinitrotoluene	8270	73	ug/l
2,6-Dinitrotoluene	8270	37	ug/l
Di-n-octyl phthalate	8270	730	ug/l
bis(2-Ethylhexyl) phthalate	8270	6	ug/l
Fluoranthene	8270	1500	ug/l
Fluorene	8270	1500	ug/l
Hexachlorobenzene	8270	0.66	ug/l
Hexachlorobutadiene	8270	14	ug/l
Hexachlorocyclopentadiene	8270	0.15	ug/l
Hexachloroethane	8270	75	ug/l
Indeno(1,2,3-cd)pyrene	8270	9.2	ug/l
Isophorone	8270	7100	ug/l
2-Methylnaphthalene	8270	-	-
Naphthalene	8270	1500	ug/l
2-Nitroaniline	8270	2.2	ug/l
3-Nitroaniline	8270	110	ug/l
4-Nitroaniline	8270	110	ug/l
Nitrobenzene	8270	3.4	ug/l
2-Nitrophenol	8270	-	-
4-Nitrophenol	8270	2300	ug/l
N-Nitrosodi-n-propylamine	8270	0.96	ug/l
N-Nitrosodiphenylamine	8270	1400	ug/l
Pentachlorophenol	8270	1	ug/l
Phenanthrene	8270	-	-
Phenol	8270	22000	ug/l
Pyrene	8270	1100	ug/l
1,2,4-Trichlorobenzene	8270	70	ug/l
2,4,5-Trichlorophenol	8270	3700	ug/l
2,4,6-Trichlorophenol	8270	610	ug/l
TCL PESTICIDES & PCBs			
Aldrin	8080	0.4	ug/l
alpha-BHC	8080	1.1	ug/l
beta-BHC	8080	3.7	ug/l
delta-BHC	8080	-	-
gamma-BHC (Lindane)	8080	0.2	ug/l
alpha-Chlordane	8080	2	ug/l
gamma-Chlordane	8080	2	ug/l
4,4'-DDD	8080	20	ug/l
4,4'-DDE	8080	20	ug/l
4,4'-DDT	8080	20	ug/l
Dieldrin	8080	0.42	ug/l
Endosulfan I	8080	-	-
Endosulfan II	8080	-	-
Endosulfan sulfate	8080	-	-
Endrin	8080	0.2	ug/l
Endrin aldehyde	8080	-	-
Endrin ketone	8080	-	-
Heptachlor	8080	0.23	ug/l
Heptachlor epoxide	8080	0.12	ug/l
Methoxychlor	8080	40	ug/l
Toxaphene	8080	3	ug/l
Aroclor-1016	8080	0.5	ug/l
Aroclor-1221	8080	0.5	ug/l
Aroclor-1232	8080	0.5	ug/l
Aroclor-1242	8080	0.5	ug/l
Aroclor-1248	8080	0.5	ug/l

Footnotes provided on page 4

TABLE 4-2

AQUEOUS SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1] Groundwater	HEALTH-BASED CRITERIA[2]	
		Limit	Unit
Aroclor-1254	8080	0.5	ug/l
Aroclor-1260	8080	0.5	ug/l

NOTES:
1. Analytical methods may be determined by the actual concentration detected and the health-based criteria.
2. Health-based criteria will be used as detection limits for groundwater and surface water samples, and do not apply to leachate or seep samples. Actual quantitation limits provided by the laboratory will be equal to or less than the health-based criteria. The actual quantitation limits will be provided by the laboratory in the addendum to the QAPP.

- : Not applicable.
ug/L: micrograms per liter
mg/L: milligrams per liter
Groundwater samples will be analyzed for total and dissolved metals constituents.
Leachate and surface water samples will be analyzed for total metals constituents.
PCBs = Polychlorinated Biphenyls.
TCL = Target Compound List.

TABLE 4-3

GROUNDWATER SAMPLE RADIONUCLIDE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA	
		Limit	Units
Gross Alpha, Total and Dissolved	9310	5	pCi/L
Gross Beta, Total and Dissolved	9310	1	--
Radium-226, Total and Dissolved	9315A	5	pCi/L
Thorium-230, Total and Dissolved	U-NAS-NS-3050	82.7	pCi/L
Uranium-234, 235, and 238, Total and Dissolved	U-NAS-NS-3050	30	pCi/L

NOTES:

pCi/L = pico curies per liter

-- : Not applicable

1. Analytical methods may be determined by actual concentrations detected and the health-based criteria.
2. Actual quantitation limits provided by the laboratory will be equal to or less than the health-based criteria. The actual quantitation limits will be provided by the laboratory in the addendum to the QAPP.

TABLE 4-4

SEDIMENT SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA LIMITS[2]	
		Limit	Units
RCRA SUBTITLE D APPENDIX I METALS			
Antimony	7041	410	mg/kg
Arsenic	7060	160	mg/kg
Barium	6010	72000	mg/kg
Beryllium	6010	67	mg/kg
Cadmium	6010	510	mg/kg
Chromium	6010	5100	mg/kg
Cobalt	6010	180000	mg/kg
Copper	6010	38000	mg/kg
Lead	7421	-	-
Nickel	6010	20000	mg/kg
Selenium	7740	5100	mg/kg
Silver	6010	5100	mg/kg
Sodium	6010	-	-
Thallium	7841	-	-
Vanadium	6010	7200	mg/kg
Zinc	6010	310000	mg/kg
CONVENTIONALS			
Boron	6010	92000	mg/kg
Calcium	6010	-	-
Iron	6010	-	-
Cyanide, Total	9010	20000	mg/kg
Magnesium	6010	-	-
Manganese	6010	-	-
Mercury	7470	310	mg/kg
Sulfide	9030	-	-
Total Petroleum Hydrocarbons	8015M	-	-
RCRA SUBTITLE D APPENDIX I VOLATILE ORGANIC COMPOUNDS			
Acetone	8260	100000	mg/kg
Acrylonitrile	8260	530	mg/kg
Benzene	8260	9900	mg/kg
Bromochloromethane	8260	-	-
Bromodichloromethane	8260	4600	mg/kg
Bromoform (Tribromomethane)	8260	36000	mg/kg
Bromomethane (Methyl bromide)	8260	1400	mg/kg
Carbon disulfide	8260	100000	mg/kg
Carbon tetrachloride	8260	2200	mg/kg
Chlorobenzene	8260	20000	mg/kg
Chloroethane	8260	410000	mg/kg
Chloroform (Trichloromethane)	8260	47000	mg/kg
Chloromethane (Methyl chloride)	8260	22000	mg/kg
1,2-Dibromo-3-chloropropane	8260	200	mg/kg
Dibromochloromethane	8260	3400	mg/kg
1,2-Dibromoethane (Ethylene dibromide)	8260	3.4	mg/kg
trans-1,4-Dichloro-2-butene	8260	-	-
1,2-Dichlorobenzene (o-DCB)	8260	92000	mg/kg
1,4-Dichlorobenzene (p-DCB)	8260	12000	mg/kg
1,1-Dichloroethane	8260	100000	mg/kg
1,2-Dichloroethane	8260	3100	mg/kg
1,1-Dichloroethene	8260	480	mg/kg
cis-1,2-Dichloroethene	8260	10000	mg/kg
trans-1,2-Dichloroethene	8260	20000	mg/kg
1,2-Dichloropropane	8260	4200	mg/kg
cis-1,3-Dichloropropene	8260	-	-
trans-1,3-Dichloropropene	8260	-	-
Ethylbenzene	8260	100000	mg/kg
2-Hexanone	8260	-	-
Methyl ethyl ketone (2-Butanone)	8260	610000	mg/kg
Methyl iodide (Iodomethane)	8260	-	-
Methyl isobutyl ketone (4-Methyl-2-pentanone)	8260	82000	mg/kg
Methylene bromide (Dibromomethane)	8260	10000	mg/kg

Footnotes provided on page 3

TABLE 4-4

SEDIMENT SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA LIMITS[2]	
		Limit	Units
Methylene chloride (Dichloromethane)	8260	38000	mg/kg
Styrene	8260	200000	mg/kg
1,1,1,2-Tetrachloroethane	8260	11000	mg/kg
1,1,2,2-Tetrachloroethane	8260	1400	mg/kg
Tetrachloroethene	8260	5500	mg/kg
Toluene	8260	200000	mg/kg
1,1,1-Trichloroethane	8260	92000	mg/kg
1,1,2-Trichloroethane	8260	5000	mg/kg
Trichloroethene	8260	26000	mg/kg
Trichlorofluoromethane (Freon 11)	8260	310000	mg/kg
1,2,3-Trichloropropane	8260	41	mg/kg
Vinyl acetate	8260	100000	mg/kg
Vinyl chloride	8260	150	mg/kg
Xylenes	8260	100000	mg/kg
TCL SEMIVOLATILE ORGANIC COMPOUNDS			
Acenaphthene	8270	61000	mg/kg
Acenaphthylene	8270	-	-
Anthracene	8270	310000	mg/kg
Benzo(a)anthracene	8270	390	mg/kg
Benzo(a)pyrene	8270	39	mg/kg
Benzo(b)fluoranthene	8270	390	mg/kg
Benzo(ghi)perylene	8270	-	-
Benzo(k)fluoranthene	8270	3900	mg/kg
4-Bromophenyl phenyl ether	8270	59000	mg/kg
Butyl benzyl phthalate	8270	200000	mg/kg
Carbazole	8270	-	-
p-Chloro-m-cresol (4-Chloro-3-methylphenol)	8270	-	-
4-Chloroaniline	8270	4100	mg/kg
bis(2-Chloroethoxy)methane	8270	-	-
bis(2-Chloroethyl)ether	8270	260	mg/kg
bis(2-Chloroisopropyl)ether [bis(2-Chloro-1-methyleth	8270	4100	mg/kg
2-Chloronaphthalene	8270	82000	mg/kg
2-Chlorophenol	8270	5100	mg/kg
4-Chlorophenyl phenyl ether	8270	-	-
Chrysene	8270	39000	mg/kg
m-Cresol (3-Methylphenol)	8270	51000	mg/kg
o-Cresol (2-Methylphenol)	8270	51000	mg/kg
p-Cresol (4-Methylphenol)	8270	5100	mg/kg
Dibenzo(a,h)anthracene	8270	39	mg/kg
Dibenzofuran	8270	-	-
1,3-Dichlorobenzene (m-DCB)	8270	91000	mg/kg
3,3'-Dichlorobenzidine	8270	640	mg/kg
2,4-Dichlorophenol	8270	3100	mg/kg
Diethyl phthalate	8270	820000	mg/kg
Dimethyl phthalate	8270	1000000	mg/kg
2,4-Dimethylphenol	8270	20000	mg/kg
Di-n-butyl phthalate	8270	100000	mg/kg
4,6-Dinitro-o-cresol	8270	-	-
2,4-Dinitrophenol	8270	2000	mg/kg
2,4-Dinitrotoluene	8270	2000	mg/kg
2,6-Dinitrotoluene	8270	1000	mg/kg
Di-n-octyl phthalate	8270	20000	mg/kg
bis(2-Ethylhexyl) phthalate	8270	20000	mg/kg
Fluoranthene	8270	41000	mg/kg
Fluorene	8270	41000	mg/kg
Hexachlorobenzene	8270	180	mg/kg
Hexachlorobutadiene	8270	3700	mg/kg
Hexachlorocyclopentadiene	8270	7200	mg/kg
Hexachloroethane	8270	20000	mg/kg
Indeno(1,2,3-cd)pyrene	8270	390	mg/kg
Isophorone	8270	300000	mg/kg
2-Methylnaphthalene	8270	-	-

Footnotes provided on page 3

TABLE 4-4

SEDIMENT SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA LIMITS[2] Limit	Units
Naphthalene	8270	41000	mg/kg
2-Nitroaniline	8270	61	mg/kg
3-Nitroaniline	8270	3100	mg/kg
4-Nitroaniline	8270	3100	mg/kg
Nitrobenzene	8270	510	mg/kg
2-Nitrophenol	8270	-	-
4-Nitrophenol	8270	63000	mg/kg
N-Nitrosodi-n-propylamine	8270	41	mg/kg
N-Nitrosodiphenylamine	8270	58000	mg/kg
Pentachlorophenol	8270	2400	mg/kg
Phenanthrene	8270	-	-
Phenol	8270	610000	mg/kg
Pyrene	8270	31000	mg/kg
1,2,4-Trichlorobenzene	8270	10000	mg/kg
2,4,5-Trichlorophenol	8270	100000	mg/kg
2,4,6-Trichlorophenol	8270	26000	mg/kg
TCL PESTICIDES & PCBs			
Aldrin	8080	17	mg/kg
alpha-BHC	8080	45	mg/kg
beta-BHC	8080	160	mg/kg
delta-BHC	8080	-	-
gamma-BHC (Lindane)	8080	220	mg/kg
alpha-Chlordane	8080	220	mg/kg
gamma-Chlordane	8080	220	mg/kg
4,4'-DDD	8080	1200	mg/kg
4,4'-DDE	8080	840	mg/kg
4,4'-DDT	8080	840	mg/kg
Dieldrin	8080	18	mg/kg
Endosulfan I	8080	-	-
Endosulfan II	8080	-	-
Endosulfan sulfate	8080	-	-
Endrin	8080	310	mg/kg
Endrin aldehyde	8080	-	-
Endrin ketone	8080	-	-
Heptachlor	8080	64	mg/kg
Heptachlor epoxide	8080	31	mg/kg
Methoxychlor	8080	5100	mg/kg
Toxaphene	8080	260	mg/kg
Aroclor-1016	8080	37	mg/kg
Aroclor-1221	8080	37	mg/kg
Aroclor-1232	8080	37	mg/kg
Aroclor-1242	8080	37	mg/kg
Aroclor-1248	8080	37	mg/kg
Aroclor-1254	8080	37	mg/kg
Aroclor-1260	8080	37	mg/kg

NOTES:

1. Analytical methods may be determined by actual concentrations detected and the health-based criteria.
2. Actual quantitation limits provided by the laboratory will be equal to or less than the health-based criteria. The actual quantitation limits will be provided by the laboratory in the addendum to the QAPP.

- : Not applicable
mg/kg: milligrams per kilogram
TCL: Target Compound List
PCBs: Polychlorinated Biphenyls

TABLE 4-5
SOIL SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA[2] Limit	Units
RCRA SUBTITLE D APPENDIX I METALS			
Antimony	7041	410	mg/kg
Arsenic	7060	160	mg/kg
Barium	6010	72000	mg/kg
Beryllium	6010	67	mg/kg
Cadmium	6010	510	mg/kg
Chromium	6010	5100	mg/kg
Cobalt	6010	180000	mg/kg
Copper	6010	38000	mg/kg
Iron	6010	-	-
Lead	7421	-	-
Nickel	6010	20000	mg/kg
Selenium	7740	5100	mg/kg
Silver	6010	5100	mg/kg
Sodium	6010	-	-
Thallium	7841	-	-
Vanadium	6010	7200	mg/kg
Zinc	6010	310000	mg/kg
CONVENTIONALS			
Boron	6010	92000	mg/kg
Calcium	6010	-	-
Magnesium	6010	-	-
Cyanide, Total	9010	20000	mg/kg
Manganese	6010	-	-
Mercury	7470	310	mg/kg
Sulfide	9030	-	-
Total Petroleum Hydrocarbons	8015M	-	-
Total Organic Carbon (TOC)	-	-	-
RCRA APPENDIX I VOLATILE ORGANIC COMPOUNDS			
Acetone	8260	100000	mg/kg
Acrylonitrile	8260	530	mg/kg
Benzene	8260	9900	mg/kg
Bromochloromethane	8260	-	-
Bromodichloromethane	8260	4600	mg/kg
Bromoform	8260	36000	mg/kg
Bromomethane	8260	1400	mg/kg
Carbon disulfide	8260	100000	mg/kg
Carbon tetrachloride	8260	2200	mg/kg
Chlorobenzene	8260	20000	mg/kg
Chloroethane	8260	410000	mg/kg
Chloroform	8260	47000	mg/kg
Chloromethane	8260	22000	mg/kg
1,2-Dibromo-3-chloropropane	8260	200	mg/kg
Dibromochloromethane	8260	3400	mg/kg
1,2-Dibromoethane	8260	3.4	mg/kg
trans-1,4-Dichloro-2-butene	8260	-	-
1,2-Dichlorobenzene (o-DCB)	8260	92000	mg/kg
1,4-Dichlorobenzene (p-DCB)	8260	12000	mg/kg
1,1-Dichloroethane	8260	100000	mg/kg
1,2-Dichloroethane	8260	3100	mg/kg
1,1-Dichloroethene	8260	480	mg/kg
cis-1,2-Dichloroethene	8260	10000	mg/kg
trans-1,2-Dichloroethene	8260	20000	mg/kg
1,2-Dichloropropane	8260	4200	mg/kg
cis-1,3-Dichloropropene	8260	-	-
trans-1,3-Dichloropropene	8260	-	-
Ethylbenzene	8260	100000	mg/kg
2-Hexanone	8260	-	-
Methyl ethyl ketone	8260	610000	mg/kg
Methyl iodide	8260	-	-
Methyl isobutyl ketone	8260	82000	mg/kg
Methylene bromide	8260	10000	mg/kg

Footnotes provided on page 3

TABLE 4-5

SOIL SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA[2] Limit	Units
Methylene chloride (Dichloromethane)	8260	38000	mg/kg
Styrene	8260	200000	mg/kg
1,1,1,2-Tetrachloroethane	8260	11000	mg/kg
1,1,2,2-Tetrachloroethane	8260	1400	mg/kg
Tetrachloroethene	8260	5500	mg/kg
Toluene	8260	200000	mg/kg
1,1,1-Trichloroethane	8260	92000	mg/kg
1,1,2-Trichloroethane	8260	5000	mg/kg
Trichloroethene	8260	26000	mg/kg
Trichlorofluoromethane (Freon 11)	8260	310000	mg/kg
1,2,3-Trichloropropane	8260	41	mg/kg
Vinyl acetate	8260	100000	mg/kg
Vinyl chloride	8260	150	mg/kg
Xylenes	8260	100000	mg/kg
TCL SEMIVOLATILE ORGANIC COMPOUNDS			
Acenaphthene	8270	61000	mg/kg
Acenaphthylene	8270	-	-
Anthracene	8270	310000	mg/kg
Benzo(a)anthracene	8270	390	mg/kg
Benzo(a)pyrene	8270	39	mg/kg
Benzo(b)fluoranthene	8270	390	mg/kg
Benzo(ghi)perylene	8270	-	-
Benzo(k)fluoranthene	8270	3900	mg/kg
4-Bromophenyl phenyl ether	8270	59000	mg/kg
Butyl benzyl phthalate	8270	200000	mg/kg
Carbazole	8270	-	-
p-Chloro-m-cresol	8270	-	-
4-Chloroaniline	8270	4100	mg/kg
bis(2-Chloroethoxy)methane	8270	-	-
bis(2-Chloroethyl)ether	8270	260	mg/kg
bis(2-Chloroisopropyl)ether [bis(2-Chloro-1	8270	4100	mg/kg
2-Chloronaphthalene	8270	82000	mg/kg
2-Chlorophenol	8270	5100	mg/kg
4-Chlorophenyl phenyl ether	8270	-	-
Chrysene	8270	39000	mg/kg
m-Cresol	8270	51000	mg/kg
o-Cresol	8270	51000	mg/kg
p-Cresol	8270	5100	mg/kg
Dibenzo(a,h)anthracene	8270	39	mg/kg
Dibenzofuran	8270	-	-
1,3-Dichlorobenzene	8270	91000	mg/kg
3,3'-Dichlorobenzidine	8270	640	mg/kg
2,4-Dichlorophenol	8270	3100	mg/kg
Diethyl phthalate	8270	820000	mg/kg
Dimethyl phthalate	8270	1000000	mg/kg
2,4-Dimethylphenol	8270	20000	mg/kg
Di-n-butyl phthalate	8270	100000	mg/kg
4,6-Dinitro-o-cresol	8270	-	-
2,4-Dinitrophenol	8270	2000	mg/kg
2,4-Dinitrotoluene	8270	2000	mg/kg
2,6-Dinitrotoluene	8270	1000	mg/kg
Di-n-octyl phthalate	8270	20000	mg/kg
bis(2-Ethylhexyl) phthalate	8270	20000	mg/kg
Fluoranthene	8270	41000	mg/kg
Fluorene	8270	41000	mg/kg
Hexachlorobenzene	8270	180	mg/kg
Hexachlorobutadiene	8270	3700	mg/kg
Hexachlorocyclopentadiene	8270	7200	mg/kg
Hexachloroethane	8270	20000	mg/kg
Indeno(1,2,3-cd)pyrene	8270	390	mg/kg
Isophorone	8270	300000	mg/kg
2-Methylnaphthalene	8270	-	-
Naphthalene	8270	41000	mg/kg

Footnotes provided on page 3

TABLE 4-5

SOIL SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA[2]	
		Limit	Units
2-Nitroaniline	8270	61	mg/kg
3-Nitroaniline	8270	3100	mg/kg
4-Nitroaniline	8270	3100	mg/kg
Nitrobenzene	8270	510	mg/kg
2-Nitrophenol	8270	-	-
4-Nitrophenol	8270	63000	mg/kg
N-Nitrosodi-n-propylamine	8270	41	mg/kg
N-Nitrosodiphenylamine	8270	58000	mg/kg
Pentachlorophenol	8270	2400	mg/kg
Phenanthrene	8270	-	-
Phenol	8270	610000	mg/kg
Pyrene	8270	31000	mg/kg
1,2,4-Trichlorobenzene	8270	10000	mg/kg
2,4,5-Trichlorophenol	8270	100000	mg/kg
2,4,6-Trichlorophenol	8270	26000	mg/kg
TCL PESTICIDES & PCBs			
Aldrin	8080	17	mg/kg
alpha-BHC	8080	45	mg/kg
beta-BHC	8080	160	mg/kg
delta-BHC	8080	-	-
gamma-BHC (Lindane)	8080	220	mg/kg
alpha-Chlordane	8080	220	mg/kg
gamma-Chlordane	8080	220	mg/kg
4,4'-DDD	8080	1200	mg/kg
4,4'-DDE	8080	840	mg/kg
4,4'-DDT	8080	840	mg/kg
Dieldrin	8080	18	mg/kg
Endosulfan I	8080	-	-
Endosulfan II	8080	-	-
Endosulfan sulfate	8080	-	-
Endrin	8080	310	mg/kg
Endrin aldehyde	8080	-	-
Endrin ketone	8080	-	-
Heptachlor	8080	64	mg/kg
Heptachlor epoxide	8080	31	mg/kg
Methoxychlor	8080	5100	mg/kg
Toxaphene	8080	260	mg/kg
Aroclor-1016	8080	37	mg/kg
Aroclor-1221	8080	37	mg/kg
Aroclor-1232	8080	37	mg/kg
Aroclor-1242	8080	37	mg/kg
Aroclor-1248	8080	37	mg/kg
Aroclor-1254	8080	37	mg/kg
Aroclor-1260	8080	37	mg/kg

NOTES:

1. Analytical methods may be determined by the total concentrations detected and the heath-based criteria.
2. Actual quantitation limits provided by the laboratory will be equal to or less than the health-based criteria limits. The actual quantitation limits will be provided by the laboratory in the addendum to the QAPP.

- : Not applicable

mg/kg: milligrams per kilogram

TCL: Target Compound List

PCBs: Polychlorinated Biphenyls

TABLE 4-6
GAS SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD	HEALTH-BASED CRITERIA[2] Limit	Units
VOLATILE ORGANIC COMPOUNDS			
Acetone	TO-14	370	ug/m^3
Benzene	TO-14	22	ug/m^3
Benzyl Chloride	TO-14	3.7	ug/m^3
Bromodichloromethane	TO-14	10	ug/m^3
Bromoform	TO-14	160	ug/m^3
Bromomethane	TO-14	5.2	ug/m^3
Carbon disulfide	TO-14	10	ug/m^3
Carbon tetrachloride	TO-14	12	ug/m^3
Chlorobenzene	TO-14	21	ug/m^3
Chloroethane	TO-14	10000	ug/m^3
Chloroform	TO-14	7.8	ug/m^3
Chloromethane	TO-14	99	ug/m^3
Dibromochloromethane	TO-14	7.5	ug/m^3
1,2-Dibromoethane	TO-14	0.81	ug/m^3
1,2-Dichlorobenzene	TO-14	210	ug/m^3
1,3-Dichlorobenzene	TO-14	320	ug/m^3
1,4-Dichlorobenzene	TO-14	26	ug/m^3
Dichlorodifluoromethane (Freon 12)	TO-14	210	ug/m^3
1,1-Dichloroethane	TO-14	520	ug/m^3
1,2-Dichloroethane	TO-14	6.9	ug/m^3
1,1-Dichloroethene	TO-14	3.6	ug/m^3
cis-1,2-Dichloroethene	TO-14	37	ug/m^3
trans-1,2-Dichloroethene	TO-14	73	ug/m^3
1,2-Dichloropropane	TO-14	9.2	ug/m^3
cis-1,3-Dichloropropene	TO-14	4.8	ug/m^3
trans-1,3-Dichloropropene	TO-14	4.8	ug/m^3
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	TO-14	-	-
Ethylbenzene	TO-14	1000	ug/m^3
4-Ethyltoluene	TO-14	-	-
Hexachlorobutadiene	TO-14	8.1	ug/m^3
2-Hexanone	TO-14	-	-
Methyl ethyl ketone	TO-14	1000	ug/m^3
Methyl isobutyl ketone	TO-14	84	ug/m^3
Methylene chloride	TO-14	380	ug/m^3
Styrene	TO-14	1000	ug/m^3
1,1,2,2-Tetrachloroethane	TO-14	3.1	ug/m^3
Tetrachloroethene	TO-14	310	ug/m^3
Toluene	TO-14	420	ug/m^3
1,2,4-Trichlorobenzene	TO-14	210	ug/m^3
1,1,1-Trichloroethane	TO-14	1000	ug/m^3
1,1,2-Trichloroethane	TO-14	11	ug/m^3
Trichloroethene	TO-14	100	ug/m^3
Trichlorofluoromethane (Freon 11)	TO-14	730	ug/m^3
1,1,2-Tirchloro-1,2,2-Trifluoroethane (Freon 113)	TO-14	31000	ug/m^3
1,3,5-Trimethylbenzene	TO-14	1.5	ug/m^3
1,2,4-Trimethylbenzene	TO-14	1.8	ug/m^3
Vinyl acetate	TO-14	210	ug/m^3
Vinyl chloride	TO-14	2.1	ug/m^3
p-Xylene	TO-14	310	ug/m^3
m- or o-Xylene	TO-14	730	ug/m^3

NOTES:
1. Analytical methods may be determined by the actual concentration detected and the health-based criteria.
2. Actual quantitation limits provided by the laboratory will be equal to or less than the health-based criteria. The actual quantitation limits will be provided by the laboratory in the addendum to the QAPP.

- : Not applicable
ug/cm3: micrograms per cubic centimeter

TABLE 4-7

GEOTECHNICAL ANALYSES

Geotechnical Analyses		Soil Samples		
			Landfill Cap	
Test	ASTM Method Number	Overburden Samples	Remedial Investigation	Feasibility Study
Grain Size (Sieve and Hydrometer)	D442	X	X	
Atterberg Limits	D4318	X	X	X
Moisture Content	D2216	X	X	X
Standard Proctor	D698	X	X	
Remold Permeability	D5084	X	X	
Undisturbed Permeability	D5084	X	X	
Dry Density	D2937	X	X	
Hydraulic Conductivity	D5084			X
Particle Size (Hydrometer)	D422			X
Soil Classification	D2488			X

CLIENT/PROJECT: LAIDLAW WASTE SYSTEMS INC.	WEST LAKE LANDFILL OPERABLE UNIT 2		
TITLE: SITE GROUNDWATER MONITORING WELLS			
Golder Associates, Denver, Colorado	DRAWN: TMC	DATE: APRIL 1995	
	CHECKED: CER	SCALE: AS SHOWN	
	REVIEWED: WEH	JOB NO. 943-2848	
	APPROVED	DWG. NO. D044	
	FILE NO. 2848D044	FIGURE 4-1	

REV.	DATE	DESCRIPTION	DR. BY	APP. BY


PZ-100-SS
PZ-100-SD
PZ-100-KS
PZ-208-SS
PZ-202-SS
PZ-200-SS
PZ-102-SS
PZ-201-SS
PZ-1201-SS
BOUNDARY OF OPERABLE UNIT 2
PZ-104-SS
PZ-104-SD
PZ-104-KS
PZ-115-SS
PZ-114-AS
PZ-103-SS
OPERABLE UNIT 1 AREA 1
PZ-101-SS
PZ-203-SS
ST. CHARLES ROCK ROAD
ACTIVE PERMITTED SANITARY LANDFILL (PERMIT #118912)
PZ-105-SS
PZ-109-SS
PZ-207-AS
PZ-110-SS
PZ-108-SS
PZ-111-SD
PZ-111-KS
ACTIVE PERMITTED DEMOLITION LANDFILL (PERMIT #218912)
PZ-113-AS
PZ-113-AD
PZ-113-SS
PZ-206-SS
PZ-112-AS
APPROXIMATE LOCATION OF UNDERGROUND STORAGE TANK SITE
PZ-305-AS
PZ-305-AI
PZ-106-SS
PZ-106-SD
PZ-106-KS
PZ-204-SS
PZ-205-AS
PZ-205-SS
PZ-107-SS
INACTIVE LEACHATE TREATMENT PONDS
BORROW AREA
OPERABLE UNIT 1 AREA 2
PZ-301-SS
OLD ST. CHARLES ROCK ROAD
INACTIVE LANDFILL AND MINE SPOIL AREA
PZ-302-AS
PZ-302-AI
LEACHATE RETENTION POND
SB-04
SB-03
PZ-304-AS
PZ-304-AI
SB-02
SB-01
PZ-303-AS
EARTH CITY INDUSTRIAL PARK STORM WATER RETENTION POND
PZ-300-AD
PZ-300-SS
PZ-300-AI
PZ-300-AS
LEGEND
PZ-110-K PROPOSED PIEZOMETER LOCATION
SB-04 PROPOSED SOIL BORING NEAR MW-F2
KEY TO WELL AND PIEZOMETER IDENTIFICATION
MW = MONITORING WELL
PZ = PIEZOMETER
100 SERIES = ADJACENT TO ACTIVE PERMITTED SANITARY LANDFILL
200 SERIES = WITHIN 500 FT. OF ACTIVE PERMITTED SANITARY LANDFILL
300 SERIES = AROUND PERMITER OF INACTIVE LANDFILL
NORTH
SCALE IN FEET
0 100 200 400
CLIENT/PROJECT
LAIDLAW
LAIDLAW WASTE SYSTEMS INC.
WEST LAKE LANDFILL OPERABLE UNIT 2
TITLE
PROPOSED PIEZOMETER LOCATIONS
Denver, Colorado
Golder Associates
DRAWN TMC
CHECKED CER
REVIEWED WEH
DATE APRIL 1995
SCALE AS SHOWN
JOB NO. 943-2848
DWG. NO. D006
FILE NO. 2848D006
FIGURE 4-2
REV. DATE DESCRIPTION DR. BY APP. BY

NOTE:
1. THE BACKGROUND SURFACE WATER SAMPLING POINT WILL BE SOUTH OF S-80, I-50 AND D-91 WELLS.

NORTH

SCALE IN FEET

0 100 200 400

LEGEND

⊗ PROPOSED EARTH CITY STORM WATER RETENTION POND SURFACE WATER AND SEDIMENT SAMPLING LOCATION

Golder Associates DENVER, COLORADO

CLIENT/PROJECT

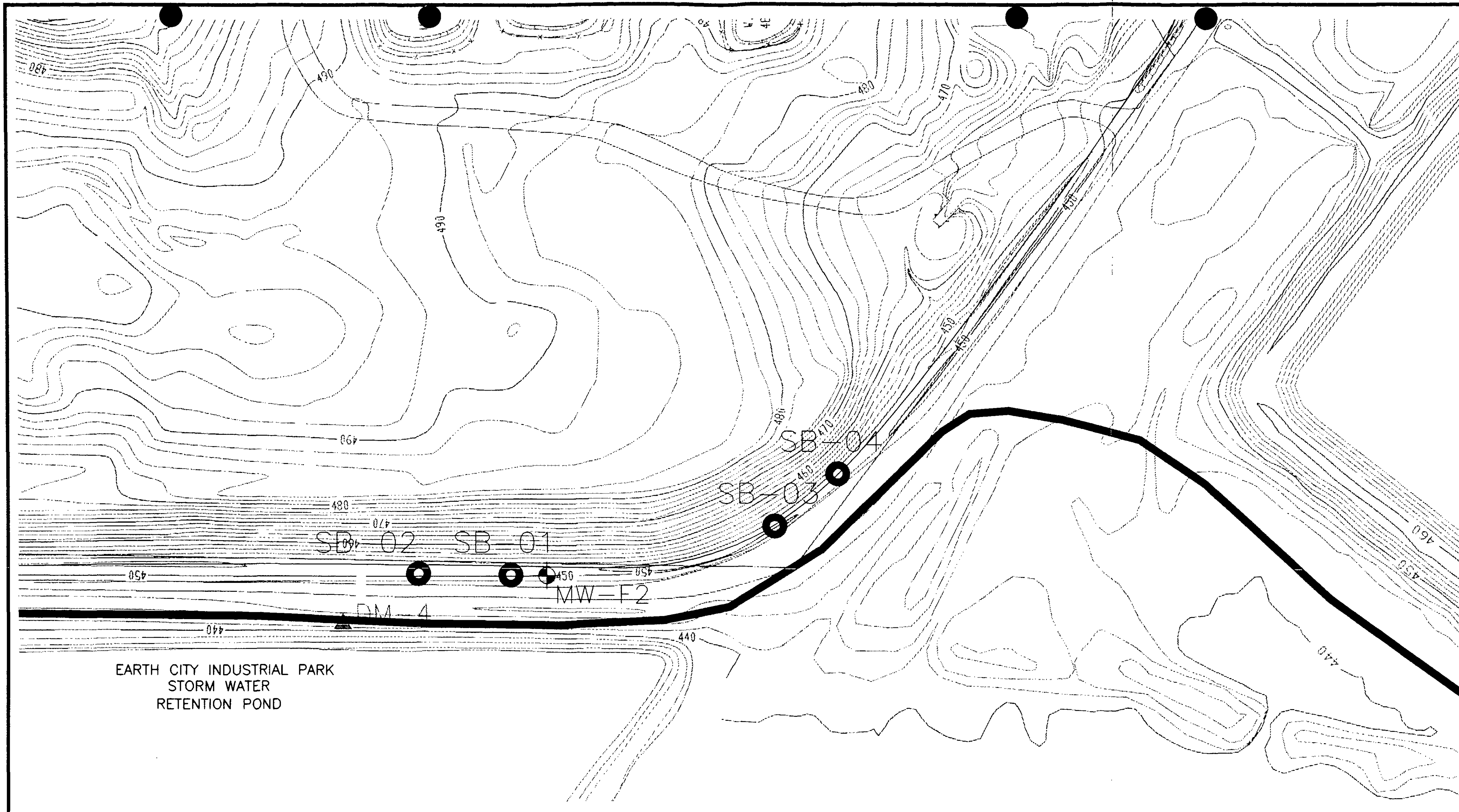
LAIDLAW
LAIDLAW WASTE SYSTEMS INC.

WEST LAKE LANDFILL OPERABLE UNIT 2

TITLE

PROPOSED SURFACE WATER SAMPLING AND SEDIMENT LOCATIONS

DRAWN	TMC	DATE	APRIL 1995	JOB NO.	943-2848
CHECKED	CER	SCALE	AS SHOWN	DWG. NO./REV. NO.	B061
REVIEWED	WEH	FILE NO.	2848B061	FIGURE NO.	4-3



LEGEND

o SB-04 PROPOSED SOIL BORING NEAR MW-F2

NORTH

SCALE IN FEET

0 100 200 400

Golder Associates DENVER, COLORADO

CLIENT/PROJECT

LAIDLAW

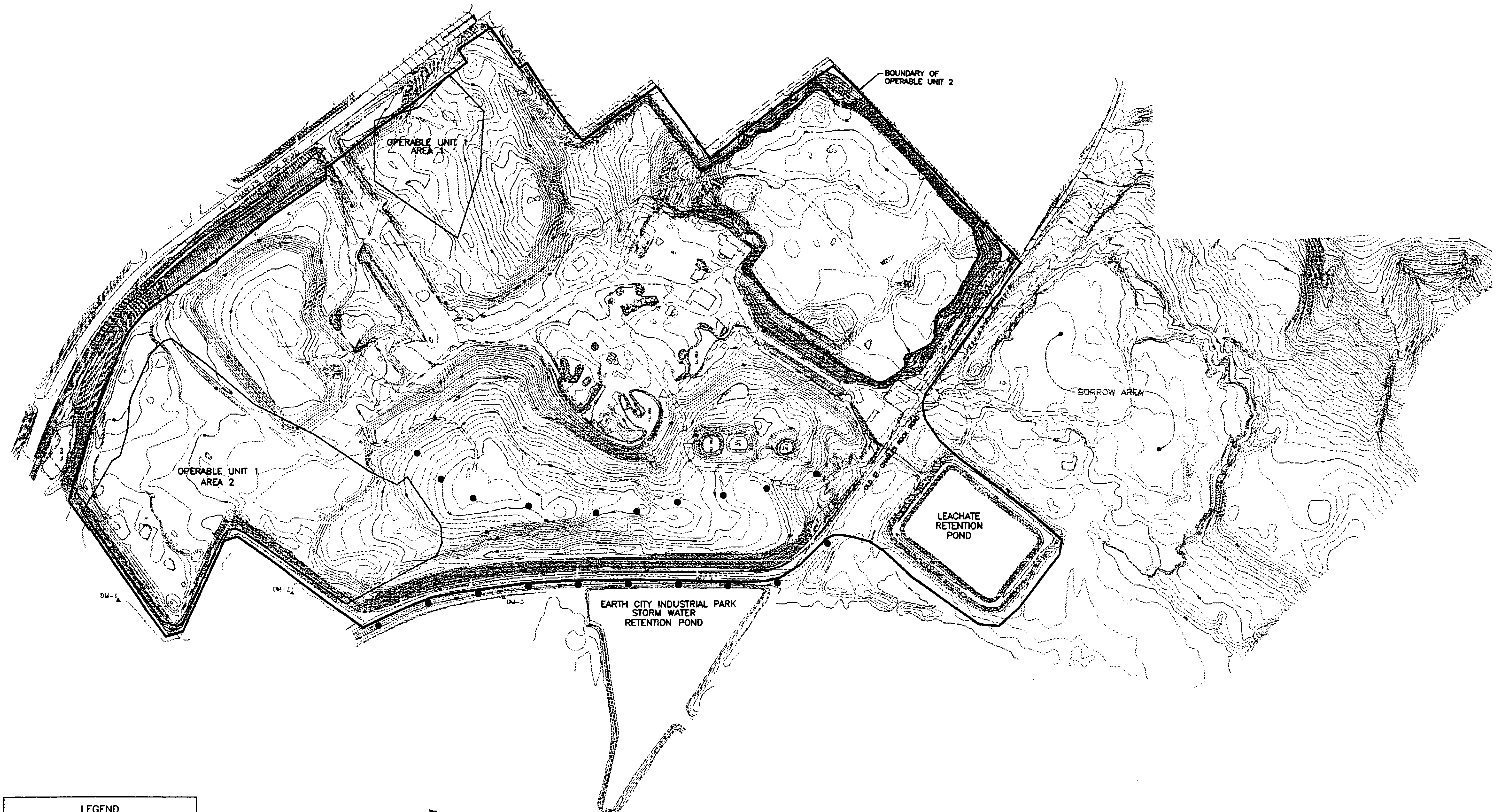
LAIDLAW WASTE SYSTEMS INC.

WEST LAKE LANDFILL
OPERABLE UNIT 2

TITLE

PROPOSED SOIL BORING LOCATIONS

DRAWN	TMC	DATE	APRIL 1995	JOB NO.	943-2848
CHECKED	CER	SCALE	AS SHOWN	DWG. NO./REV. NO.	B060
REVIEWED	WEH	FILE NO.	2848B060	FIGURE NO.	4-4



LEGEND

- ● PROPOSED INACTIVE LANDFILL CREST GAS SAMPLING LOCATIONS
- ● PROPOSED WESTERN BOUNDARY LANDFILL GAS SAMPLING LOCATIONS

NORTH

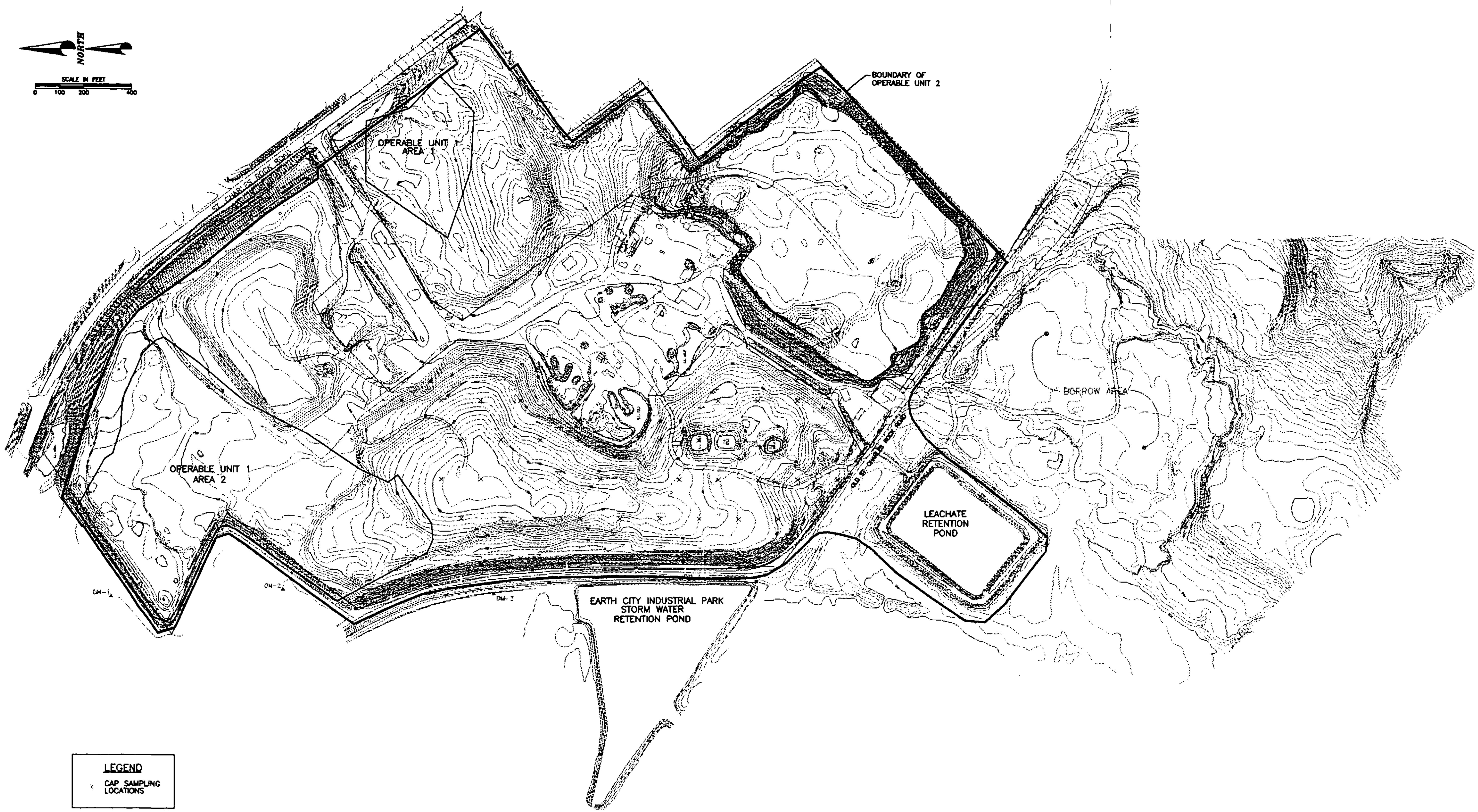
SCALE IN FEET 0 100 200 400

Golder Associates — Denver, Colorado

CLIENT/PROJECT: LAIDLAW WASTE SYSTEMS INC. — WEST LAKE LANDFILL OPERABLE UNIT 2

TITLE: **PROPOSED LANDFILL GAS SAMPLING LOCATIONS**

DRAWN	TMC	DATE	APRIL	JOB NO.	943-2848
CHECKED	CER	SCALE	AS SHOWN	DWG. NO./REV. NO.	B050
REVIEWED	WEH	FILE NO.	2848B050	FIGURE NO.	4-5



Golder Associates
Denver, Colorado

CLIENT/PROJECT
LAIDLAW WASTE SYSTEMS INC.
WEST LAKE LANDFILL
OPERABLE UNIT 2

TITLE
PROPOSED CAP INVESTIGATION
SAMPLING LOCATIONS

DRAWN TMC	DATE APRIL 1995	JOB NO. 943-2848
CHECKED CER	SCALE AS SHOWN	DWG. NO./REV. NO. B062
REVIEWED WEH	FILE NO. 2848B062	FIGURE NO. 4-6

5.0 SAMPLE DESIGNATION

All samples obtained during the RI will be uniquely identified and containers will be indelibly labeled. The samples will be prefixed as to their origin. Borehole samples will be prefixed by "PZ"; leachate riser samples by "LR"; surface soil samples by "SO"; sediment samples by "SE"; surface water by "SW"; ground water by "GW"; leachate samples by "LC"; soil gas by "SG"; and landfill gas by "LG." Samples will be further identified by the borehole, leachate riser or monitor well number(s) and, if applicable, their respective depth. Surface soil, surface water, and sediment samples will be also be identified with a location number which will be generated prior to sampling.

Sample designations for QA/QC samples will be sufficed to the prefix of origin. The following suffices will be used:

TB = Trip Blank
EB = Equipment Blank
FB = Field Blank
D = Duplicate
a or b = split

For example: PZ-112-15'-a indicates a subsurface soil sample from piezometer 112, at a depth of 15-feet, and the first of a split sample.

GW-201-SS indicates a groundwater sample collected from PZ-201-SS.

GW-TB-2 indicates the second trip blank obtained during ground water sampling.

6.0 SAMPLING EQUIPMENT AND PROCEDURES

The purpose of this section is to provide a detailed description of the equipment and procedures that will be used to perform each of the data collection activities that comprise the RI/FS field program. All field activities will be recorded in field log books and other appropriate data forms, and photo-documented where appropriate. All sampling equipment will be decontaminated in accordance with the procedures described in Section 8.0. Field activities will also be conducted in accordance with the Site Health and Safety Plan (Appendix B). Equipment necessary to conduct decontamination, record field activities, and comply with the Site Health and Safety Plan is not itemized for each task listed in this section.

6.1 Site Physical and Biological Characterization

This subtask includes three separate work activities to be performed:

- ▷ Surficial geologic investigation;
- ▷ Ecological evaluation; and,
- ▷ Collection of additional information on site physical characteristics and demographics.

6.1.1 Surficial Geologic Investigation

6.1.1.1 Equipment and Material

Equipment needed for the surficial geologic investigation may include:

- ▷ A site topographic map and available aerial photographs;

- Brunton compass;
- Hand auger with core barrel;
- Measuring tape;
- Stakes and colored flagging tape; and,
- Permanent markers.

6.1.1.2 Procedures

A surficial geologic investigation will be performed to define surficial geology, current drainage patterns, site geomorphology, site cultural features, and to evaluate landfill settlement. The surficial geologic investigation will entail the following discrete field activities:

- Map surficial soil types and compare to available soil maps;
- Map the location of bedrock outcrops, determine the strike and dip of these units and confirm the stratigraphic column for the site;
- Identify seep locations and confirm previously identified surface water bodies and discharge points;
- Confirm the limits of the landfilled areas;
- During the field work, develop a surficial geologic map for the site; and,
- Based on the site topographic mapping and the surficial geologic mapping map, the location of site drainage features including major divides will be identified.

Mapping will be carried out by experienced geologists with available aerial photographs and topographic maps using pace or measuring tapes and Brunton compass techniques.

During the surficial geologic investigation, field personnel will also identify areas of stressed vegetation, leachate seeps, and stained soils/sediments (if present), which may indicate an impact of the landfill on the environment. If observed, these areas will be located by tape or pace and compass methods and referenced to the site coordinate system. If noticeable odors are detected in impacted areas, air monitoring may be conducted with a photoionization detector (PID). In addition, the impacted areas will be photographed for inclusion in the site photographic record. Field personnel will record their observations in the field logbook.

The surficial geologic investigation will also include a detailed review of available aerial photographs to determine, if possible, the rate of landfill settlement for the inactive landfill. If available, stereoscopic aerial photographs will be reviewed.

6.1.2 Ecological Evaluation

The SOW for OU-2 requires that an ecological evaluation be performed to evaluate the flora and fauna of one site, identify critical habitats and endangered species, and describe the ecological setting of the site and the surrounding area. The SOW for OU-1 requires a similar ecological evaluation which, based on the schedule provided in the OU-1 *RI/FS Work Plan for the West Lake Site, Bridgeton, Missouri* (McLaren/Hart, 1994a) was completed in May 1994. The ecological evaluation conducted by McLaren/Hart for OU-1, if available, will be reviewed to determine if this evaluation is sufficient to meet the AOC requirements for OU-2. If the OU-1 ecological evaluation is determined to be insufficient, supplemental activities will be performed to address the outstanding issues. A separate Field Sampling Plan for the OU-2 ecological evaluation will be developed, if necessary, and submitted to the EPA for approval prior to initiation of ecological evaluation field activities.

6.1.3 Site Physical Characteristics and Demographics

This activity will include a literature review and field verification of information as required. The data collection activities will focus on updating geologic, hydrogeologic, hydrologic, ecologic, climatic, land use and demographic information for the site and surrounding area. The literature review will consist of an analysis of available information from the following sources:

- U.S. Geological Survey;
- Missouri Department of Natural Resources;
- Soil Conservation Survey;
- City and County studies;
- Department of Commerce;
- University studies;
- Private studies or reports; and,
- Any other relevant sources.

Information obtained from these sources will be compiled and evaluated for relevance to site conditions. Finally, the data will be compared to field conditions, when appropriate.

6.2 Hydrogeologic Characterization

6.2.1 Piezometer Borehole Drilling

6.2.1.1 Equipment and Materials

The following equipment and materials will be required during drilling of piezometer boreholes:

- Alluvium: Drill rig equipped with 3.25-inch inside diameter (I.D.) hollow stem augers or other appropriate equipment and split spoon or continuous type sampler;

  Bedrock: Rotary drill rig equipped with 6-inch nominal diameter tricone roller bit, wireline sampling system and N-sized, split, double, or triple tube core barrels;

- Shelby tubes, or equivalent, and caps;

- Core boxes;

- Zip-loc™ bags (or equivalent freezer bags);

- Potable water;

- Field Record Forms including Soil Borehole Logs, Core Logs, Chain-of-Custody Forms, Sample Tracking Forms, request for analysis forms, shipping forms and sample tags;

- Water level indicator;

- Weighted tape; and,

- Stakes and flagging.

6.2.1.2 Procedures

All field sampling equipment will be decontaminated in accordance with the procedures described in Section 8.0.

Prior to the initiation of borehole drilling, a utilities clearance will be obtained to locate and identify all underground installations in the vicinity of borehole locations. Additionally, a sample of potable water used for circulation during water rotary drilling will be collected and analyzed for groundwater parameters listed in Table 4-2.

Table 3-2 lists the proposed piezometers that will be completed as part of the hydrogeologic investigation. In summary the piezometer installation program includes:

- 4 piezometers completed in the limestone sequence below the shales of the Warsaw Shale;
- 23 piezometers completed in the upper part of the Salem/St. Louis Limestone;
- 4 piezometers completed in the lower portion of the Salem/St. Louis Limestone; and,
- 16 piezometers completed in the alluvium (10 water table, 4 intermediate, 2 at base of alluvial aquifer).

The rationale and classification system for the piezometer network is provided in Section 3.4.2.2 of this FSP.

Overburden Drilling

All overburden (i.e., loess or alluvium) piezometer boreholes will be advanced using a truck mounted drill rig equipped with 3.25-inch I.D. hollow stem augers (HSA) until the target depth or bedrock is encountered. The target depth for each of the alluvial piezometers is included in Table 3-2. In addition, Table 3-2 provides the proposed interval for continuous sampling of the soil boring.

Sampling of the overburden will allow for direct observation of the overburden material at the site. Continuous sampling will allow the compilation of a continuous loess and alluvium stratigraphic profile. Sampling the overburden will assist in determining piezometer screen intervals.

Single boreholes/piezometer locations will be continuously sampled. The deeper boreholes in borehole pairs or clusters will be sampled continuously to obtain a continuous stratigraphic profile to the maximum depth of drilling. Duplicating sampling efforts for shallow boreholes in a pair or cluster is unnecessary. Soils will be continuously sampled using split spoon or continuous type sampling methods and logged on standard forms by a qualified geologist, engineer or technician. Sampling sand and gravel below the water table may be difficult, and sample recovery may be poor. Samples of these stratigraphic units may be obtained from cuttings or from the augers as they are retrieved from the boreholes.

The overburden material descriptions will include geologic origin where appropriate, blow counts (if samplers are driven), color (Munsell color chart), and will be classified according to the Unified Soil Classification System (USCS) using ASTM Methods D2487 and D2489. Geologic boring logs will be prepared and include overburden material descriptions, drilling and sampling methods, sample depth intervals, land surface elevations, and total depth of the boring. An example of a standard boring log is included, along with other standard field forms, as Attachment 1 to this FSP.

Samples for the geotechnical analyses (Section 4.3.2) will be obtained from the screened intervals of selected boreholes. The sample selection process will be based on sample recovery and distribution of soil types encountered.

During borehole construction of the "300-" series alluvial monitoring wells, one soil sample corresponding to the screened interval will be obtained and analyzed for Total Organic Carbon (TOC). The TOC sample will be placed in an appropriate sample jar and submitted for analysis following sample handling and analysis procedures described in Section 7.0.

Drill cuttings and other excess materials removed from the borehole will be handled in accordance with the procedures described in Section 9.0.

Bedrock Drilling

Table 3-2 indicates that 31 of the piezometers will be completed in bedrock. Each of these piezometers will be drilled through the overburden using the drilling methods discussed above. At the shallower bedrock piezometers at each cluster, the borehole will be drilled through bedrock using a 5 7/8-inch diameter tricone roller bit to advance the borehole to the target depth for coring (i.e., top of proposed screen interval). At these shallower bedrock piezometers, the borehole will be cored across the depth interval provided in Table 3-2. In some instances it may be necessary to install a temporary casing through the overburden and into bedrock to minimize the loss of circulation water during coring.

For three of the piezometers completed into the Keokuk Limestone (PZ-104-KS, PZ-106-KS, and PZ-111-KS), the boreholes will be cored to the top of the Warsaw Shale (assumed to be a potential aquitard) and will then be reamed to a nominal 8-inch diameter using a 7 7/8-inch diameter tricone roller bit. A permanent casing will then be grouted into the top of the Warsaw Shale, using a cement-bentonite grout. After the grout has set for a minimum of 24 hours, the piezometer borehole will be advanced into the Keokuk Limestone using an N-sized double or triple tube coring system.

Coring will allow for precise stratigraphic control of the underlying bedrock and will define aquifer thickness and characteristics. Direct observation of the rock core samples allows identification of the geologic properties of the rock, such as fracture zones which may behave as preferred groundwater flow pathways. Core samples will allow for selection of packer test intervals and determination of screen intervals.

Bedrock coring will be conducted using N-sized split double or triple tube core barrels in conjunction with a wireline recovery system. Split double or triple core barrels will provide for collection of minimally disturbed samples. Wireline recovery systems will expedite recovery of samples by negating the need to retrieve drill rods during rock core sample recovery.

The geologic and geotechnical characteristics of the rock core will be logged and photographed before the core is transported. Core samples will be logged in the core barrel, prior to being placed in core boxes. All core samples will be logged on rock core logging forms. An example rock core log form is included in Attachment 1.

The geologic characteristics of the rock core will be described in terms of rock type, geologic structure, degree of weathering, and rock color. Geotechnical parameters which will be logged include core recovery, fracture frequency, rock strength and Rock Quality Designation (RQD). Graphic logs depicting lithology and fracture orientation (relative to the core axis) are also included on the log forms. Discontinuities will be described according to type, shape and surface characteristics. The weathered state of the sample will be classified according to the International Society for Rock Mechanics (ISRM) system for weathering characteristics. The ISRM classification will also be used to qualitatively estimate the strength of the sample. The color of the core will be derived from the Geological Society of America Rock Color Chart.

Structure observed in the rock core will be described in terms of flow banding, foliation, bedding, lamination, grading etc. The orientation of the structure will be specified with respect to the core axis.

After logging, the core will be placed in core boxes. Rock core may need to be broken for efficient placement in the core boxes. The stratigraphic orientation of the core will be indicated by two continuous parallel lines inscribed on the core, red on the left and green on the right, looking downhole. When placing the core in the core boxes the top of the core is placed in the top left corner of the box, and the core is boxed from left to right, top to bottom of the box. Each core box will be indelibly labeled with the project name and/or number, the borehole number, the box number, and the depth at the start and end of core.

Some rock core samples of the Warsaw Shale may be preserved for potential geotechnical laboratory testing. The core samples may be tested for vertical permeability (ASTM 4525). Testing will depend on the quality of information obtained from packer testing (Section 6.2.3). The core will be preserved by wrapping the sample in plastic wrap and aluminum foil. The top of the rock core will be indelibly marked. The sample will then be completely coated with hot wax. The hardened wax preserves the moisture content and the integrity of the sample.

6.2.2 Borehole Geophysics

6.2.2.1 Equipment and Materials

The following equipment and material may be necessary for the borehole geophysics investigation:

- ▷ Logging vehicle equipped with downhole sondes (tools), electric winch, and computerized processing equipment; and,
- ▷ Potable water.

6.2.2.2 Procedures

All downhole equipment will be decontaminated in accordance with the procedures described in Section 8.0.

Geophysical logging will be performed at the four deep bedrock borings (i.e., PZ-100-KS, PZ-104-KS, PZ-106-KS, and PZ-111-KS) targeted for the limestone sequence below the shales of the Warsaw Shale (assumed to be the Keokuk Formation). The borehole geophysics program for this investigation may include, as necessary, natural gamma ray, caliper, resistivity, neutron, and gamma-gamma density.

Natural gamma logs record intensity in natural radiation emitted from the boring rock wall. This method is primarily used for identification of lithology and stratigraphic correlation through the interpretation of both the absolute amount and variations in emissions as measured continuously.

Caliper logging equipment will be used to measure both roughness and size of the borehole. These data are recorded continuously and used in the interpretation of rock types, hardness variations, and fracture size and frequency.

The main objective of the gamma-gamma log will be to determine the bulk density of rocks in an open hole. A source of gamma radiation (cesium-137) irradiates the formations. The emitted gamma rays interact with the electrons of the matter around the well bore, and a gamma detector above the source counts the back scatter rays. The intensity of the back scatter rays depends on the electron density of the matter penetrated (rather than the chemical nature of the atom as in the neutron log described below). It has been shown that the response of a gamma-gamma tool is an exponential function of the density of the medium, with denser materials having lower count rates. Landfills, waste sites, glacial fills, and cased holes are not considered optimum conditions for running density logs. However, it is another tool that can contribute information in making proper geophysical evaluations of these anthropogenic sites.

The neutron log will show high counts in hard rock and low counts in hydrogen-rich materials, such as shales and clays. The neutron log will correlate (approximately) with the porosity of the formation.

6.2.3 Packer Testing

6.2.3.1 Equipment and Materials

The following materials and equipment may be required during constant head injection testing of piezometers:

- Expandable gasket system dual packer;
- Pump and pressure gauges; and,
- Potable water.

6.2.3.2 Procedures

All downhole equipment will be decontaminated in accordance with the procedures described in Section 8.0.

Constant head injection packer tests will be conducted in the four deep boring locations (PZ-100-KS, PZ-104-KS, PZ-106-KS, and PZ-111-KS) prior to piezometer installation.

The single and double packer assemblies, consisting of one or two sliding-end pneumatic packer(s) connected to a perforated pipe, are used in conjunction with surface control equipment to perform the hydrologic packer testing. The surface assembly consists of a variable rate water pump for controlling water injection, a flow meter manifold, a pressure gauge, valving, hoses, and a data acquisition system.

The packer assembly is connected to the surface assembly using drill rods. The drill rods are also used to lower the packer assembly into the borehole and to provide a conduit for water injection. The downhole packer assembly is raised and lowered within the borehole using a drill rig.

High-pressure nitrogen cylinders are used to inflate the packers. The packers are inflated to a pressure of 150 to 250 pounds per square inch (psi) above the static water pressure at the top of the tested interval. Packer inflation pressures vary with the hole diameter and the static water pressure exerted on the test zone. To minimize the potential of injection water leaking past the packers during testing, packers rated to a confined inflation pressure of 1000 psi are used. Each sliding end packer has a gland length of 5 feet before inflation and an approximate gland length of about three feet after inflation.

The surface assembly is used to monitor the pressure and flow rate into the test interval. Pressure and flow rate readings are recorded manually by direct observation of the pressure gauge and flow meters. The frequency of readings can be varied, but are generally recorded at intervals of 30 seconds to 2 minutes. The pressure (head) exerted on the test interval is a combination of the gauge pressure plus the pressure induced by gravity (elevation head). The elevation head is the distance from the pressure gauge to the static water level. If the static water level is below the test interval, then the elevation head is the distance from the pressure gauge to the center of the test interval.

Packer test zones are selected using information collected from rock core and geophysical logs developed from a borehole. Test intervals are selected by isolating bedrock zones which appear to exhibit some geologic significance. Test zones of geologic significance at the West Lake Landfill may include:

- ▷ The uppermost zone in the St. Louis Formation (weathered bedrock-loess contact). This zone represents an unsaturated zone that may potentially transmit landfill gas;

- ▷ Zones which exhibit very high or very low density of fractures as identified from the rock core and geophysical logs collected from a borehole. The fractured and unfractured test zones are significant since they should represent the upper and lower bounds of hydraulic conductivity, respectively, of the bedrock surrounding the site; and,

- Zones which exhibit specific geologic characteristics within the rock core (vugs, solution features, silicification, etc.) and/or the geophysical logs (high clay or shale content, distinct caliper deflection, very high or very low porosity, etc.).

Single packer tests use a single pneumatic packer set at the top of the test zone. Single packer tests are used as the borehole is advanced or if the bottom of the borehole is included within the zone of interest. Double (two) pneumatic straddle packers are set around zones of significance within a borehole to perform testing of the zone. The bottom of the borehole serves as the lower point of test confinement for a single packer test. Double packer tests are performed when a specific zone of interest within the borehole is to be tested.

A constant head test method using pressure injection is applied to the test zones of interest. This test method is used because it can be completed in a relatively short time period and allows for measurement of a wide range of hydraulic conductivity values. This method of testing involves pressurizing the test interval with water injected at a constant pressure, ensuring that the pressure does not significantly exceed consolidation pressure, and continuing the tests until a constant flow rate into the test interval can be obtained. For pre-test setup, the consolidation pressure can be assumed to be approximately 1 psi of injection pressure per foot of test depth (e.g., if the top of the test zone is 100 feet below the ground surface, the injection pressure should not exceed 100 psi). Flow rates into the test interval, and hence the injection pressure, are stepped up incrementally and held steady for approximately 10 minutes to allow the pressure within the test zone to stabilize. Estimates of hydraulic conductivity are subsequently calculated using a constant head analysis method.

Pressure data and flow rates are recorded during the performance of each test. Because water is injected until a constant flow rate and stabilized pressures (or head) within the test intervals are established, a steady state flow analysis method is applicable (Logan, 1964). When reporting the calculations and test interpretation, the specific equations for the test will be provided.

6.2.4 Piezometer Installation

6.2.4.1 Equipment and Material

The following equipment and materials will be required during installation of piezometers:

- Drill rig equipped with 3.25-inch inside diameter (I.D.) hollow stem augers for alluvium piezometers;
- Rotary drill rig for bedrock piezometers;
- 2-inch I.D. Schedule 40 or Schedule 80 PVC with flush threaded joints and 0.010-inch machine slotted screen for alluvium piezometers, 2-inch I.D. Schedule 80 PVC with flush threaded joints and 0.010-inch machine slotted screen for bedrock piezometers;
- 2-inch I.D. Schedule 40 PVC or Schedule 80 PVC riser with flush threaded joints for alluvium and bedrock piezometers, respectively;
- Lockable protective covers;
- Piezometer caps and padlocks;
- Filter pack sand;
- Buffer sand;
- Bentonite pellets/chips;
- Volclay™/Bentonite grout mix;
- Concrete;
- Potable water;

- Field Record Forms including Soil Borehole Logs, Chain of Custody Forms, Sample Tracking Forms, request for analysis forms, shipping forms and sample tags;
- Water level indicator; and,
- Weighted tape measure.

6.2.4.2 Procedures

All downhole equipment will be decontaminated in accordance with the procedures described in Section 8.0.

The following sections describe construction procedures specific to bedrock and alluvial piezometers, and provide details about construction procedures common to both bedrock and alluvial piezometers.

Bedrock Piezometers

After completion of the coring at each of the bedrock piezometers, the borehole will be reamed to a nominal 6-inch diameter using a 5 7/8 inch O.D. tricone roller bit. The borehole will be reamed to the top of the proposed screened interval, followed by continuous coring across the proposed screened interval. At the bedrock piezometers to be screened in the Salem/St. Louis Limestone, the piezometers will be constructed directly in the reamed borehole.

At three of the deep borings into the Keokuk Limestone (PZ-104-KS, PZ-106-KS, and PZ-111-KS), the upper Salem/St. Louis Limestone and Warsaw Shale will be cased off prior to the borehole being advanced into the Keokuk. As discussed in Section 6.2.1.2, this procedure will require that a minimum 8-inch diameter borehole be completed to the top of the Warsaw Shale, and that a permanent 6-inch diameter casing be installed to the Warsaw Shale. Once the permanent casing is installed, the borehole will be cored to the target depth. The borehole will then be reamed to a nominal 6-inch diameter using rotary drilling methods. The deep piezometers will be constructed in the same manner as that specified for the shallow bedrock piezometers.

Geophysics can be conducted either before or after reaming, depending on scheduling constraints. Packer testing will be conducted after the boreholes are reamed.

The bedrock piezometers will be constructed of 2-inch diameter, 10-feet long (minimum) with flush threaded joints, 0.010-inch factory slotted, Schedule 80 PVC screen. Flush threaded Schedule 80 PVC riser pipe will be connected to the screen and extend from the screened interval to 2 to 2.5 feet above the ground surface.

Piezometer screen lengths will vary depending upon the aquifer monitored. Piezometers completed into the Keokuk Limestone will be drilled 20 feet below the top of this aquifer, and will be screened across the bottom 10 feet of the borehole. Piezometers completed into the alluvium and Salem/St. Louis Limestone will be screened across the bottom 10 feet of the borehole.

Four proposed piezometers located east of the facility (PZ-200-SS, PZ-201-SS, PZ-202-SS, and PZ-203-SS) will be constructed with a modified design. Specifically, the screen will extend from approximately 10 feet below ground surface to approximately 10 feet below the water table. These piezometers may be used for both groundwater and landfill gas monitoring purposes.

Alluvial Piezometers

Alluvial piezometers will be constructed using 2-inch I.D. flush threaded Schedule 40 or Schedule 80 PVC riser pipe and 0.010-inch machine slotted screen. Screens will be approximately 10 feet in length. The riser will extend approximately 2 feet above the ground surface and will be fitted with a vented cap.

Bedrock and Alluvial Piezometer Construction Details

The filter pack for piezometers will be 20/40 environmental grade silica sand or sand with equivalent grain size distribution. The filter pack will extend to a height of about 3 feet above the screen interval. A minimum 6-inch thick buffer of fine sand will be placed over the filter pack to minimize the potential for the bentonite seal or grout to penetrate the filter pack.

A minimum 3-foot bentonite pellet, chip, or slurry seal will be placed over the buffer sand. The annular seal will be allowed to hydrate, or set, for at least 30 minutes before proceeding to grout the remaining annulus. This procedure minimizes the potential for the seal to penetrate the filter pack when the overlying annulus is grouted. The grout will be placed to within 3 to 5 feet of the ground surface. Bentonite/grout will be mixed at the surface prior to being pumped in the hole. The auger string will be raised incrementally during placement of the sand pack, buffer sand, annular seal and grout in the overburden.

A corrosion resistant locking protective cover will be installed over the piezometer and set in approximately 3 feet of concrete. The concrete supporting the protective cover will be confined to a boring that is at least 2 feet larger in diameter than the casing, and will be sloped away from the cover to promote drainage. To minimize the potential for heaving, the concrete will not be allowed to "mushroom" over the ground surface. Weep holes will be drilled through the protective cover and washed pea gravel will be placed inside the cover above the ground surface to promote drainage. A schematic for a typical piezometer is shown on Figure 6-1.

Each piezometer will be marked with the appropriate designation (Section 3.4.2.2) on the outside and inside of the protective cover. Piezometers will be secured with keyed-alike padlocks. Three, minimum 3-inch diameter, metal bumper posts will be installed around each of the newly installed piezometers.

A minimum of 24 hours after installation, the piezometers will be developed according to the procedures described in Section 6.2.6. Following development, in-situ permeability testing will be performed in each piezometer as described in Section 6.2.7.

6.2.5 Piezometer Surveying

A land surveyor registered in the State of Missouri will determine the location and elevations of all wells and piezometers. Borings will be located to the nearest 0.1 foot, and elevations of the top of inner casings of the piezometers will be measured to 0.01 foot. All elevation measurements, grid patterns and coordinates will be referenced to North American Datum (NAD) 1983 and National Geodetic Vertical Datum (NGVD) 1929.

Survey data will be used to relate the piezometers to the site coordinate system. All newly constructed piezometers will be included on pertinent maps generated for the OU-2 RI/FS.

6.2.6 Piezometer Development

6.2.6.1 Equipment

The following materials and equipment may be required during development of piezometers:

- Water level indicator;
- Positive displacement pump system (e.g., submersible);
- Bailers;
- pH, conductivity, and turbidity meters, thermometer, and calibration kits;
- Containers for collection of purge water;
- Field Record Forms including Well Development forms; and,
- Surge block.

6.2.6.2 Procedures

All downhole equipment will be decontaminated in accordance with the procedures described in Section 8.0.

A minimum of 24 hours after installation, the piezometers will be developed using the above-listed equipment. Consistent with State of Missouri regulations, well development will be conducted using either a surge block to work the screened interval of the well, or a pump or bailer to remove water and sediments in the well (MDNR, 1993). The development of the well will proceed using this methodology until the turbidity of the water is minimized. Turbidity, pH, specific conductance, and temperature will be monitored at regular intervals during development. Development will continue, if possible, until the turbidity of the extracted water is less than 5.0 NTU (+/- 5 NTU), ten borehole volumes (casing plus filter pack), or at least three times the volume of water used during drilling have been removed. Wells which recharge too slowly for these criteria to be satisfied will be developed until a minimum of three well volumes have been withdrawn.

Pumped groundwater will be considered indicative of formation water when pH units are consistent to within 0.1 pH unit, specific conductivity does not vary by more than 10 percent and the temperature does not vary by more than 1 degree Centigrade.

Bailers will be used for development when it is impracticable to use a pump due to slow recharge.

Development water will be collected in containers and disposed of in the on-site leachate retention pond.

6.2.7 Slug Testing

6.2.7.1 Equipment and Materials

The following materials and equipment may be required during in-situ permeability testing of piezometers:

- Rod (slug);
- Distilled water;

- Nylon rope;
- Watch displaying seconds;
- Field forms;
- Transducer/data logger; and,
- Submersible pump.

6.2.7.2 Procedures

All downhole equipment will be decontaminated in accordance with the procedures described in Section 8.0.

All newly completed alluvial and bedrock piezometers will be slug tested to evaluate in-situ hydraulic conductivity. The slug tests will be performed once in each of the newly installed piezometers. An instantaneous known rise or decline in water level (i.e., falling head or rising head test) will be created by using a decontaminated rod (slug) that will be inserted or removed. In wells where the well screen intersects the water table, bailing or pumping may be used to induce a water level change for a rising head test.

A slug test provides an estimate of approximate permeability value of the formation materials screened; e.g., the test provides an approximate (order of magnitude) hydraulic conductivity for a discrete portion of the aquifer. A transducer/data logger will be used to record the response of the wells to the insertion of the rod or the adding of water.

An initial water level measurement will be taken before the test begins. If the water level is above the top of the screen, a rod, suspended by a nylon rope, will be lowered quickly into the well to increase the water level in the well. The decline of the water will be monitored until the well recovers to 90 percent of its static level or for a period of 30 minutes whichever is less. If the well recovers by at least 90 percent in the 30-minute period, the rod will be removed quickly and the rising water level will be monitored until recovery is complete or for a period of 30 minutes. Care will be taken to identify any significant effects from borehole/sandpack storage. The recovery test will not be conducted if water level recovery does not meet the above criteria.

The method of interpretation of in situ hydraulic conductivity test data will depend on the type of piezometer installation and the hydrogeologic conditions present (i.e., confined or unconfined). When reporting the results, the interpretation method and software used will be referenced.

The methods used to analyze the in situ hydraulic conductivity test data will depend on the type of piezometer installation and on the hydrogeologic conditions that exist. Appropriate analyses will be applied based on such conditions as the rate of water level recovery during a test, whether the tested unit is confined or unconfined, and if the presence of a significant skin effect is suspected or observed. Golder has developed a package of computer-based analyses that are appropriate to specific test and subsurface conditions. The package combines a group of industry standard analyses that include the Hvorslev, Bower-Rice and Ramey (a modification of the confined Cooper-Popadopolous method) slug test solutions. The results of the analyses are presented as a tabulation of the field test data, test parameters (i.e., test input and piezometer construction parameters), appropriate analytical plots, display of the equations used, and the calculated values for hydraulic conductivity.

6.2.8 Water Level Monitoring

6.2.8.1 Equipment and Materials

The following materials and equipment may be required during measurement of water levels in monitoring wells, piezometers and surface water bodies:

- Electronic water level indicator;
- Level and rod, or staff gauge;
- Measuring tape or ruler; and,
- Field Record Forms including Record of Water Level Measurement.

6.2.8.2 Procedures

All downhole equipment will be decontaminated in accordance with the procedures described in Section 8.0.

Measurements of static water levels will be taken using an electronic water level indicator. The depth to water or fluid will be measured from a marked survey location on the north rim of the riser. The static water level measurement will be recorded in the field log book and/or a Water Level Measurement Form. Depths to water or fluid will be compared in the field to previous measurements and elevations to minimize the possibility of incorrect readings. The probe or tape will be rinsed between each data point with a Liquinox™/deionized water solution followed by deionized water.

The water or fluid elevation data obtained will be used to estimate vertical and horizontal hydraulic gradients and the direction of groundwater flow. Horizontal gradients will be derived from potentiometric surface contour maps for selected hydrogeologic units.

A site-wide well integrity survey will be conducted as part of OU-1 RI/FS activities in order to determine which of the currently existing monitoring wells may be incorporated into the site monitoring network. The currently existing site wells which are deemed usable will also be incorporated in the site-wide water level survey.

Monthly water level measurement will be performed beginning with completion of all "100-" and "200-" series piezometers and continuing for 12 months after completion of all "300-" series piezometers. Concurrently, fluid levels will be obtained from the four leachate collection sumps (LCS-1 through LCS-4) in the active landfill, one leachate well (K-128), ten gas wells (W-1 through W-10), and four gas collection manholes (GC-1 through GC-4). All fluid levels will be obtained on the same day, if possible. The data points to be utilized in the water level survey, except for the currently existing wells to be identified during the OU-1 RI/FS well integrity survey, are shown in Figure 6-2.

A precipitation gauge capable of measuring precipitation events greater than 0.01 inch will be installed at an appropriate location on site concurrent with, or prior to, installation of the piezometers. Data from the gauge, combined with data to be obtained from the nearby Lambert/St. Louis International Airport, will be used to correlate fluctuations in groundwater level(s) with precipitation throughout the site characterization period.

U.S. Army Corps of Engineers daily stream flow data for the Missouri River at St. Charles will be obtained for the same period as the groundwater level measurements.

Water elevations in the Earth City Storm Water Retention Pond will be measured by installing a staff gauge or through completion of a level and rod transect from the survey benchmarks established on-site. Surface water elevations may need to be measured with a level and transect since staff gauges are prone to ice damage, frost heave and vandalism.

The surface water elevations will be measured to an accuracy of 0.1 foot. The elevation of water in the surface water bodies will be compared with groundwater elevations from nearby shallow piezometers to assess the hydraulic relationship of surface water bodies to groundwater (e.g., local recharge or discharge features).

Surface water measurements will be taken on the same day, if possible, that groundwater and fluid elevations are measured, and during the sediment sampling event.

6.2.9 Groundwater Quality Sampling

6.2.9.1 Equipment and Materials

The required sampling equipment may include the following:

- Completion details for each monitoring well to be sampled, including total depth of the well;
- Electric water level indicator;
- Stainless steel or Teflon™ bailer and submersible or bladder pump and tubing;
- Level I field equipment such as a turbidimeter, specific conductance meter, thermometer, pH meter, and calibration solutions;

- Containers for the collection of purge water;
- Plastic sheeting to place around the well head to prevent possible contamination of the sampling equipment;
- An in-line filtering apparatus with 0.45-micron filter and pump;
- Sample bottles and sample preservatives;
- Field Record forms, including Well Development and Chain-of-Custody forms, request for analysis forms, and sample labels; and,
- Coolers and ice.

6.2.9.2 Procedures

All purging and sampling equipment will be decontaminated in accordance with the procedures described in Section 8.0.

Each groundwater sampling round will commence at the hydraulically upgradient monitoring well locations and will proceed to downgradient well locations. This procedure will minimize the potential for cross-contamination.

Purging

Groundwater monitoring wells will be purged prior to sampling. Purging will be performed with a positive displacement, adjustable flow rate, bladder or submersible pump. The pump will be lowered into position so as not to disturb the water column. The intake for the pump will be positioned at the approximate mid-point of the well screen or water column, whichever is

shorter. If use of pump is not practical, the wells will be purged with bailers. A minimum of 3 well volumes will be purged from the well prior to sampling, unless the well has very slow recovery characteristics (i.e., does not recover within 2 hours).
The temperature, pH, specific conductivity, and turbidity of extracted water will be monitored during purging. Purged groundwater will be considered indicative of formation water when pH units are consistent to within 0.1 pH unit, specific conductivity does not vary by more than 10 percent and the temperature does not vary by more than 1 degree Centigrade. The value of these parameters during purging and immediately prior to sampling will be recorded on well sampling or development data sheets. Purging will be performed until field parameters have stabilized, three well volumes have been withdrawn, or the well goes dry. Purge water will be collected and disposed of in the on-site leachate retention pond.

If a well is purged dry or is purged such that full recovery exceeds two hours, the well will be sampled as soon as a sufficient volume of groundwater has entered the well to enable the collection of the necessary groundwater samples. For slow recovery wells, low flow purging and sampling methodologies may be utilized. Low flow sampling requires minimal agitation of the water column. Accordingly, the sampling pump will be slowly and carefully installed in the well and the water level may be allowed to equilibrate for up to 24 hours prior to purging and sample collection. Low yield wells may be purged using a flow rate of about 100 ml/min, for a maximum of one casing volume. Field parameters will be monitored during purging, as described above. Low flow rates will be utilized during sampling to minimize the potential for introduction of air into the samples.

Groundwater Sampling

Groundwater samples will be collected from each monitoring well in order of decreasing volatility. Thus, the following is the order of sample collection for each monitoring well:

- ▷ Volatile Organic Compounds (VOCs);
- ▷ Semivolatile Organic Compounds (SVOCs);
- ▷ Pesticides/Polychlorinated Biphenyls (PCBs);
- ▷ Metals;
- ▷ Other General Chemistry Parameters; and,
- ▷ Radionuclides.

Aliquots for each groundwater analysis will be collected directly from the pump discharge or bailer. The pump rate during sampling will be kept at a minimum to minimize aeration of the sample during collection.

The samples will be collected with a Teflon™ or stainless steel bailer with a bottom valve. The sample containers will be filled from the bottom valve of the bailer. The sample container for VOC analysis will be completely filled with no headspace.

For filtered samples, the filtering process is intended to occur with minimal sample aeration. Therefore, the inlet line will be inserted directly into the discharge stream, and the exit line from the filter will be placed in the bottom of the sample jar.

Following completion of groundwater sampling at each monitoring well, the submersible pump, bailer, and tubing will be decontaminated in accordance with the procedures specified in Section 8.0 of this FSP.

6.3 Source Characterization

6.3.1 Leachate Riser Borehole Drilling and Sampling

6.3.1.1 Equipment and Materials

The following equipment and materials will be required during drilling of leachate riser boreholes:

- ▹ Drill rig equipped with 3.25-inch I.D. hollow stem augers or other appropriate equipment and split spoon or continuous type sampler;
- ▹ Shelby tubes, or equivalent;
- ▹ Potable water;
- ▹ Field Record Forms including Soil Borehole Logs, Chain-of-Custody Forms, Sample Tracking Forms, request for analysis forms, shipping forms and sample tags;
- ▹ Water level indicator;
- ▹ Weighted tape; and,
- ▹ Stakes and flagging.

6.3.1.2 Procedures

All downhole equipment will be decontaminated in accordance with the procedures described in Section 8.0.

This investigative program will involve advancement of test borings in the six proposed locations, and subsequent evaluation to determine whether a leachate riser should be installed at each location. The test borings will be advanced at each location using hollow stem auger drilling methods, and samples of the waste materials/soils will be obtained using split-spoon or wireline samplers. Soils will be continuously sampled and logged on standard forms by a qualified geologist, engineer or technician. One sample of landfill cap material and/or liner material from each leachate riser borehole will be retained for potential geotechnical analysis.

The material descriptions will include geologic origin where appropriate (e.g., if waste rock from quarrying operations is encountered), blow counts (if samplers are driven), color (Munsell color chart), and the material will be classified according to the Unified Soil Classification System using ASTM Methods D2487 and D2489. Geologic boring logs will also include overburden material descriptions, drilling and sampling methods, sample depth intervals, land surface elevations, and total depth of the boring. An example of a standard boring log is included, along with other standard field forms, as Attachment 1 to this FSP.

The test borings will be completed to the base of the waste materials and care will be taken to avoid penetration through the landfill liner, if present. After completion of the test boring to the base of the waste, the boring will be checked for leachate level using the electronic water level indication. If leachate is encountered in the boring, a leachate riser will be completed (Section 6.3.2). If leachate is not encountered in that boring, the boring will be abandoned.

Abandonment of boreholes will be conducted according to the State of Missouri Well Construction Rules. The borings will be backfilled with a cement/bentonite grout or bentonite pellets via a tremie pipe to within 2 feet of the surface. The remainder of the boring will be filled with soil. The abandoned borehole location will be marked with stakes and flagging.

Drill cuttings and other excess materials removed from the borehole will be handled in accordance with Section 9.0, Management of Investigation-Derived Waste.

6.3.2 Leachate Riser Installation

6.3.2.1 Equipment and Materials

The following equipment and material may be required for the installation of the leachate risers:

- Drill rig equipped with minimum 3.25-inch I.D. hollow stem auger or other appropriate drilling equipment;
- 2-inch I.D. Schedule 40 PVC screen with flush threaded connections and machine cut 0.010-inch slots;
- 2-inch I.D. Schedule 40 PVC riser, with flush-threaded connections;
- Steel protective casings;
- Locking covers and locks;
- Filter pack;
- Buffer sand;
- Bentonite pellets/chips;
- Volclay™/Bentonite grout mix;

- Concrete;
- Potable water;
- Weighted measuring tape and compass;
- Stakes and flagging;
- Field Record Forms including Soil Borehole Logs, Chain-of-Custody Forms, Sample Tracking Forms, request for analysis forms, shipping forms and sample tags; and,
- Water level indicator.

6.3.2.2 Procedures

All downhole equipment will be decontaminated in accordance with the procedures described in Section 8.0.

The screen interval will extend from the base of the boring to the top of the leachate, or to a maximum length of 10 feet, whichever is less. The riser pipe will extend approximately 2 feet above the ground surface and will be fitted with a vented cap. The auger string will be raised incrementally during placement of the sand pack, buffer sand, annular seal, and grout, as described below.

The filter pack size for the leachate risers will be 20/40 sand. The filter pack will extend from the bottom of the borehole to top of the screen interval. A minimum 6-inch thick buffer of fine sand will be placed over the filter pack to minimize the potential for the bentonite seal or grout to penetrate the filter pack. The weighted tape measure will be used to measure filter pack thickness.

A minimum 3-foot thick bentonite pellet or chip seal will be placed over the buffer sand and hydrated with potable water. A minimum 10-foot thick annular seal will be placed above the bentonite seal through a side discharge tremie pipe. Bentonite/grout will be mixed at the surface prior to being pumped in the hole. The grout will be placed to within 3 to 5 feet of the ground surface.

A steel locking protective cover will be installed over the riser and set in 3 to 5 feet of concrete filling the remaining annular space. To minimize the potential for heaving, the concrete will not be allowed to "mushroom" over the ground surface. Weep holes will be drilled through the base of the protective cover and washed pea gravel will be placed inside the cover above the ground surface to promote drainage.

Each leachate riser will be marked with the appropriate designation on the outside and inside of the protective cover. Leachate risers will be secured with keyed-alike padlocks. A schematic of a typical leachate riser is depicted in Figure 6-3.

6.3.3 Leachate Riser Surveying

A land surveyor registered in the State of Missouri will determine the location and elevations of the leachate risers. Borings will be located to the nearest 0.1 foot and elevations of the top of inner casings of the leachate risers will be measured to 0.01 foot. All elevation measurements, grid patterns and coordinates must be established and used consistently throughout the investigation and referenced to North American Datum (NAD) 1983 and National Geodetic Vertical Datum (NGVD) 1929.

6.3.4 Leachate Level Monitoring

6.3.4.1 Equipment and Materials

The following materials and equipment may be required during measurement of leachate levels:

- Electric water level indicator;
- Measuring tape or ruler; and,
- Field Record Forms including Record of Water Level Measurement.

6.3.4.2 Procedures

All downhole equipment will be decontaminated in accordance with the procedures described in Section 8.0.

Measurements of leachate levels will be taken using an electronic water level indicator. The depth to leachate will be measured from a marked survey location on the north rim of the riser. The depth measurements will be recorded to the nearest 0.01 feet. The static water level measurement will be recorded in the field log book and/or a Water Level Measurement Form. The probe or tape will be washed with a Liquinox™/deionized water solution and rinsed with deionized water between each data point.

6.3.5 Leachate Sampling

6.3.5.1 Equipment and Materials

The required sampling equipment may include the following:

- Completion details for each leachate riser to be sampled, including total depth of the well;
- Electronic water level indicator;
- Stainless steel or Teflon™ bailer;
- Level I field equipment such as a turbidimeter, specific conductance meter, thermometer, pH meter, and calibration solutions;
- Plastic sheeting to place around the well head to prevent possible contamination of the sampling equipment;
- Sample bottles and sample preservatives;
- Coolers and ice; and,
- Field Record forms, including Well Development and Chain-of-Custody forms, request for analysis forms, and sample labels.

6.3.5.2 Procedures

All sampling equipment will be decontaminated in accordance with the procedures described in Section 8.0.

Leachate risers will not be purged prior to sampling. Leachate risers will be sampled using a bailer. Care will be taken during bailing to cause as little agitation of the water column as possible.

The temperature, pH, and specific conductivity of the leachate will be measured prior to sample collection. The value of these parameters will be recorded on sampling data sheets.

Aliquots will be collected directly from the bottom valve of the bailer.
Sample bottles will be filled in order of decreasing volatility, as described in Section 6.2.9.2 for groundwater samples. The sample container for VOC analysis will be completely filled with no headspace. Sample bottles will be labeled as described in Section 5 and handled as described in Section 7.

6.3.6 Landfill Gas Characterization

6.3.6.1 Equipment and Materials

The following equipment may be required in order to conduct the landfill gas survey and sample landfill gas:

- ▷ Portable gasoline-powered generator;
- ▷ 50-foot extension cord;
- ▷ 5-foot lengths of 0.5-inch I.D. threaded steel tubing, with threaded connections and drive caps;
- ▷ Teflon™ tape;

- Sacrificial drive points such as a carriage bolt which are large enough to cover the bottom of the steel tubing;
- 5/8-inch diameter solid steel rod;
- Air compressor and pneumatic post driver, or a manually operated slam bar;
- Hydraulic or mechanical jack and chain;
- PID, CGI (with hydrogen sulfide and methane meter), and calibration kits;
- Air sampling pump or peristaltic pump with flow meter;
- 12-volt battery to run air pump, if required;
- Rubber stoppers to fit the 0.5-inch I.D. steal tubing with a center hole to fit Teflon™ tubing;
- Teflon™ tubing and stainless steel connections and valves;
- Tedlar™ bags;
- SUMMA™ canisters;
- Sample coolers and ice;
- Chain-of-custody forms;
- Measuring tape and compass;
- Granular bentonite or bentonite pellets;
- Potable water;
- Stakes and colored flagging tape; and,

- Permanent markers.

6.3.6.2 Procedures

All downhole equipment will be decontaminated in accordance with the procedures described in Section 8.0.

Prior to the initiation of gas probe installation, a utilities clearance will be obtained to locate and identify all underground installations in the vicinity of borehole locations.

Temporary landfill gas probes will be installed along the crest and along the western boundary of the inactive landfill as described below. The crest locations will be screened and sampled, while the boundary locations will be screened only.

Installation Procedures

The probes will consist of 5-foot lengths of 0.5-inch I.D. steel tube with a sacrificial drive point. The probe will be assembled by placing the sacrificial drive point into the bottom of the steel drive tube. The drive point-drive tube assembly will be driven into the ground to the desired depth with the pneumatic post driver or manually with a slam bar. If difficulty is experienced advancing the 0.5-inch temporary landfill gas probe, a decontaminated 5/8-inch diameter solid steel rod may be driven to the desired depth and subsequently withdrawn, creating a pilot hole. If a pilot hole is created, the annular space around the drive tube will be sealed with a thick bentonite slurry.

Upon advancing the drive point into fill, the drive tube will be withdrawn approximately 6 inches with the hydraulic jack and chain assembly. Upon withdrawal of the drive tube, the sacrificial tip will remain at the bottom of the hole, leaving 6 inches of exposed waste/soil at the bottom of the hole. A rubber stopper with a center hole will be inserted in the top of the drive tube. Teflon™ tubing will be inserted into the probe through the center hole in the rubber stopper.

Each temporary gas probe location will be staked and marked with flagging tape. The stake will be labeled with the probe identification number. Field personnel will reference each gas probe location to the site coordinate system by tape and compass methods.

Upon completion of the landfill gas screening/sampling event, the probes will be pulled from the ground with the hydraulic jack. The resulting hole will be filled with granular bentonite (or bentonite pellets) and subsequently hydrated with potable water. Gas probes will be decontaminated with a high pressure washer prior to re-use.

Screening Procedures

Gas probe screening will be conducted with a PID and a CGI to assess the concentration of volatile organic compounds, hydrogen sulfide, and combustible gases in landfill gas at each newly-installed probe. Calibration procedures of the PID and CGI will be performed in accordance with the QAPP (Appendix A-2 of the Work Plan). If the temporary gas probes naturally vent landfill gas, screening will occur after approximately 20 minutes of venting. If the temporary gas probes do not vent naturally, they will be purged a minimum of ten probe volumes (i.e., volume of inside of probes) with an appropriate air pump prior to screening. After venting or purging is completed, a clean Tedlar™ bag will be connected to the probe, or exhaust of a peristaltic pump, and filled with gas from the probe. The instruments will be connected to the Tedlar™ bag and the measurements recorded on Air Monitoring Data Sheets. Obtaining the gas samples from full Tedlar™ bags will assure consistent volumes of landfill gas are screened.

Sampling Procedures

If the gas probe is actively venting, landfill gas will be sampled directly from the crest probe locations using evacuated SUMMA™ canisters prepared by the laboratory. The sample containers will be connected directly to naturally venting probes by Teflon™ tubing. Valves on the sample containers will be opened until the containers are full.

Non-venting probes along the inactive landfill crest will be connected to a low flow air sampling pump or peristaltic pump using a stainless steel "tee" with a threaded valve between two sections of thin-walled Teflon™ tubing. Prior to sampling, the pump will be adjusted to draw gas through the "tee" at a rate of about 80 cc/min. The probe and discharge line will be purged for a minimum of ten probe volumes. After purging is completed, the pump will be shut off and the valve on the "tee" closed. The SUMMA™ canister will be filled by opening the valve on the canister to allow gas from the probe to enter until the canister is full (pressure gauge on the canister should read 0 psi). Once the canister is full, the valve on the canister will be closed and the canister will be disconnected from the system.

6.3.7 Petroleum Investigation

6.3.7.1 Subsurface Investigation

Previous investigations have shown that environmental media near monitoring well MW-F2 may have been impacted by petroleum products. A subsurface investigation will be conducted to determine the extent and magnitude of the impacts. The investigation will include the following components:

- Installation of piezometer PZ-303-AS;
- Completion of four borings to characterize soil impacts;
- Installation of a leachate riser; and,
- Soil, leachate, and groundwater sampling.

Piezometer PZ-303-AS will be installed adjacent to well MW-F2 and will be drilled, installed, and sampled using the methodology presented in the portions of Section 6.2 devoted to the drilling, installation and sampling of alluvial piezometers. The piezometer is intended to monitor the water table interface and will be constructed to allow for monitoring of floating product (if present) as well as collection of groundwater samples. Groundwater samples will be collected as described in Section 6.2.9.

Four soil borings will be completed in the vicinity of PZ-303-AS (Figure 4-4). These soil borings will be continuously sampled to termination at the water table, and based on headspace analysis results, one soil sample will be collected from each boring for laboratory analysis. If headspace analyses does not provide an adequate criteria for obtaining a sample, a sample will be collected from the water table interval. The purpose of these borings is to evaluate the lateral extent of vadose zone impacts in this vicinity. The borings will be drilled and sampled using the methods described in Section 6.2.1. Headspace analysis is discussed in Section 6.3.7.2.

A leachate riser will be installed at the top of the berm of the inactive landfill, near PZ-303-AS. The leachate riser will be installed to determine whether a source of the petroleum products observed at MW-F2 is present within the landfill. Leachate riser LR-105 will be drilled, installed, and sampled as described in Sections 6.3.1, 6.3.2, and 6.3.5. Samples of leachate from LR-105 and groundwater samples from PZ-303-AS will be submitted for laboratory analysis of benzene, toluene, ethylbenzene, and xylenes (BTEX) as well as total petroleum hydrocarbons (TPH). The selected soil samples will also be submitted to the project laboratory for BTEX and TPH analyses. The results from this investigation will be reviewed to determine whether any additional investigation will be required to determine the source or extent of the petroleum impacts in this vicinity.

The four boreholes, the piezometer and the leachate riser associated with the investigation of potential petroleum impacts near well MW-F2 will be surveyed into the site coordinate system.

6.3.7.2 Headspace Analysis

6.3.7.2.1 Equipment and Materials

The following equipment and materials are necessary to conduct headspace analysis:

- Glass sample jars (500 ml) and caps;
- Aluminum foil;
- PID with calibration kit;
- Potable water;
- Decontamination equipment;
- Field Record Forms including Soil Borehole Logs, Chain of Custody Forms, Sample Tracking Forms, request for analysis forms, shipping forms and sample labels;
- Sample jars; and,
- Coolers with ice.

6.3.7.2.2 Procedures

Headspace analyses will be performed on recovered soil samples by immediately filling a clean jar approximately half full, covering the jar with aluminum foil, and then sealing the jar with a lid. The jars will be large enough (500 ml) to allow at least a 2-inch airspace when half filled with the sample. After the sample has been allowed to equilibrate at ambient temperature for a minimum of 15 minutes, the lid will be removed while maintaining the integrity of the aluminum foil seal. A reading with the PID will be taken from the headspace by perforating the aluminum foil with the instrument probe. The peak PID measurement from each sample will be recorded on the borehole log at the appropriate sample depth entry.

6.3.8 Surface Water, Seep, and Sediment Investigation

6.3.8.1 Surface Water and Seep Investigation

6.3.8.1.1 Equipment and Materials

The required equipment includes the following:

- ▷ A surface water sample collection bottle with a lid;
- ▷ Level I field equipment such as a specific conductance meter, turbidity meter, thermometer, and a pH meter;
- ▷ Plastic sheeting to prevent contamination of the sampling equipment;
- ▷ Sample bottles and sample preservatives;
- ▷ Coolers and ice; and,

- Field forms, including Chain-of-Custody forms, request for analysis forms, and sample labels.

6.3.8.1.2 Procedures

All sampling equipment will be decontaminated between sampling locations as discussed in Section 8.0.

A background surface water sample will be obtained from an Earth City Storm Water Retention Pond located south of the well group (S-80, I-50, D-91) near the site leachate retention pond (Figure 4-3). The background stormwater retention pond could not have been impacted by West Lake Landfill activities. The sample location will be based on ease of access.

The surface water sample from the Earth City Storm Water Retention Pond near MW-F2 will be collected from the eastern edge of the pond at a point identified in the field as most likely to be impacted by surface water runoff from the West Lake site.

The samples from both locations will be collected by lowering a closed collection bottle into the water, removing the lid when the bottle has been positioned correctly (i.e., at mid-depth with the open end facing up), and replacing the lid before bringing the filled bottle to the surface. Water will then be poured from the collection bottle into the sample jars, filling the VOA vials first and then the remaining sample jars.

Seep sample collection will be performed similarly. There may be an insufficient depth of standing water to submerge a sampling jar. In this event, a shallow depression will be made and allowed to fill from the seep. Water samples will be collected and jarred from the filled depression in the same manner as samples from the deeper water bodies. All samples collected will be unfiltered.

The Earth City Storm Water Retention Pond sampling locations will be marked by a stake on the bank of the pond, and the seep sampling locations will be staked at the sample point. The stakes will be located by surveying upon completion of the sampling. The stakes will be labeled with the sampling point identification number.

6.3.8.2 Sediment Investigation

6.3.8.2.1 Equipment and Materials

The required sampling equipment includes the following:

- Appropriate sampling device (i.e., a stainless steel core sampler and/or scoop);
- Stainless steel pan;
- Plastic sheeting to prevent contamination of the sampling equipment;
- Sample bottles;
- Field Record forms, including chain-of-custody forms, request for analysis forms, and sample labels;
- Measuring tape and compass;
- Stakes and flagging; and,
- Coolers and ice.

6.3.8.2.2 Procedures

Sampling equipment will be decontaminated between sampling locations, as discussed in Section 8.0.

Sediment samples will be taken at the Earth City Storm Water Retention Pond surface water sampling locations and at each of the defined seeps with a short coring device or scoop from the 0- to 6-inch depth interval. A sample for VOC analysis will be collected first and immediately placed in a sample jar.

6.4 Feasibility Study Data Collection

6.4.1 Landfill Cap Investigation

6.4.1.1 Equipment and Materials

The following equipment and material may be required to conduct the landfill cap investigation:

- Stakes and flagging;
- Hand auger with Shelby tubes;
- Potable water;
- Sample bags or jars;
- Measuring tape and compass; and,
- Borehole logging forms.

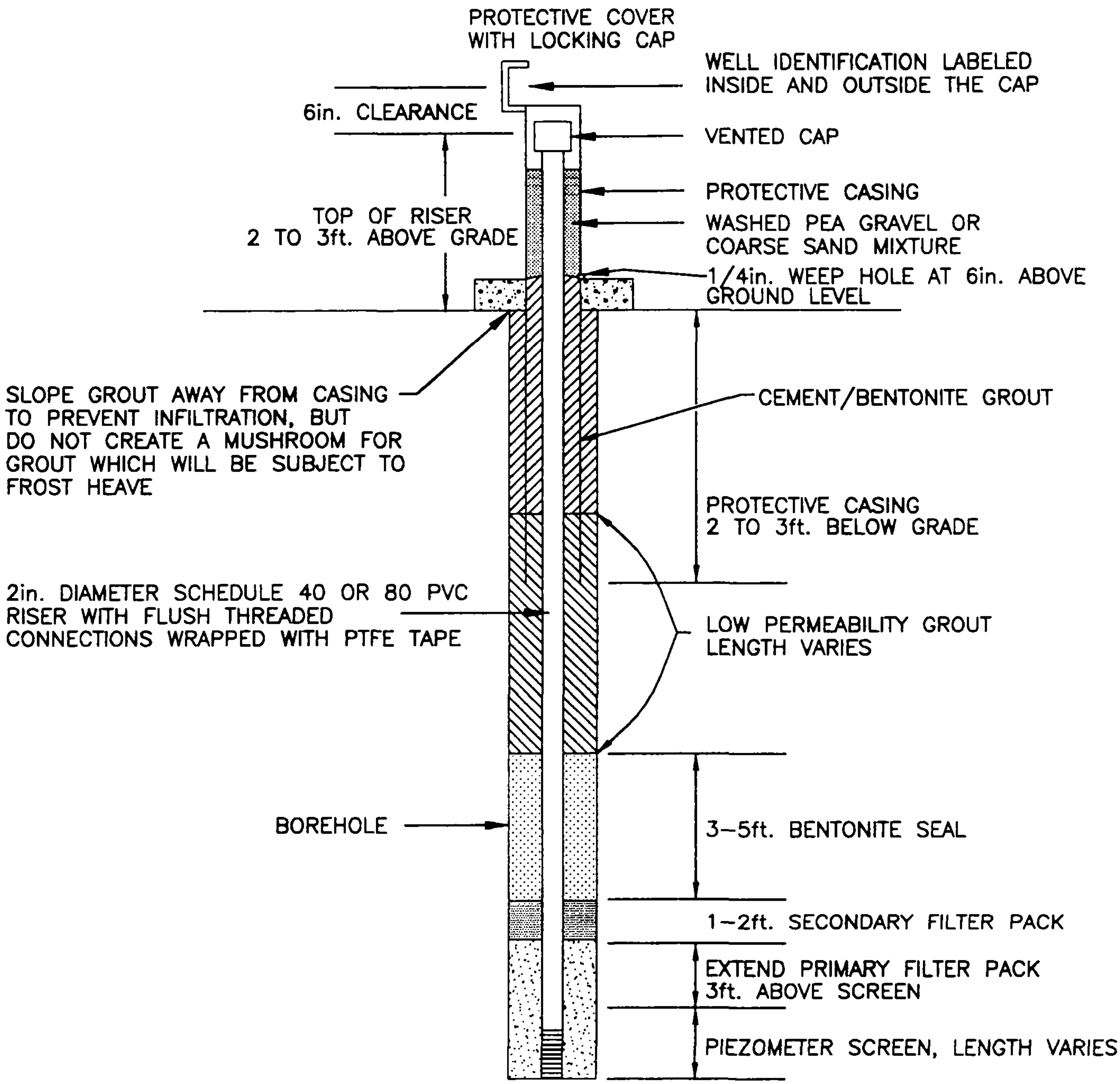
6.4.1.2 Procedures

Each proposed sampling location will be marked with stakes and flagging and surveyed by tape and compass relative to the site coordinate system. A hand auger or back hoe will be utilized to penetrate the cap material of the inactive landfill. Samples will be collected and logged continuously to a depth of 1 foot beneath the cap material.
The cap material descriptions will include geologic origin where appropriate, color (Munsell color chart) and will be classified according to the Unified Soil Classification System using ASTM Methods D2487 and D2489 by a qualified geologist, engineer or technician. The thickness and other physical properties of the cap material will be noted on borehole logs. If the cap material is measured to be at least 1.5 feet thick, cap material samples will be collected and subjected to geotechnical analysis to determine the integrity of the cap. It is anticipated that approximately 20 percent of the data points which have a cap thickness of at least two feet will be analyzed for geotechnical properties, as described in Section 4.0.

6.5 Air Quality Monitoring

Toxic and explosive vapor monitoring will be performed during all investigative tasks as part of health and safety monitoring. Air quality monitoring is described in detail in the Site Health and Safety Plan.

All health and safety air monitoring readings will be recorded in field notebooks and will include the date, time, weather conditions, wind direction, and location of the reading. In addition, background readings will be measured on a daily basis in an area distant and upwind from areas of potential contamination.



Golder Associates — Denver, Colorado

TITLE

TYPICAL PIEZOMETER CONSTRUCTION DETAIL

CLIENT/PROJECT: LAIDLAW — LAIDLAW WASTE SYSTEMS INC.

DRAWN	TMC	DATE	APRIL 1995	JOB NO.	943-2848
CHECKED	CER	SCALE	AS SHOWN	DWG NO./REV. NO.	A034
REVIEWED	WEH	FILE NO.	2848A034	FIGURE NO.	6-1

LEGEND

PZ-110-KS	PROPOSED PIEZOMETER
D-90	EXISTIMG GROUNDWATER MONITORING WELL
GC-2	EXISTING GAS COLLECTION MANHOLE
Q71	EXISTING LEACHATE COLLECTION SUMP
W-1	EXISTING GAS WELL

NORTH

SCALE IN FEET

0 100 200 400

TOPOGRAPHY NORTH OF OLD ST. CHARLES ROCK ROAD: FEBRUARY 1994

TOPOGRAPHY SOUTH OF OLD ST. CHARLES ROCK ROAD: FEBRUARY 1992

NOTE:
PROPOSED PIEZOMETERS AND HIGHLIGHTED WELLS WILL BE INCLUDED IN THE WATER LEVEL MONITORING PROGRAM.

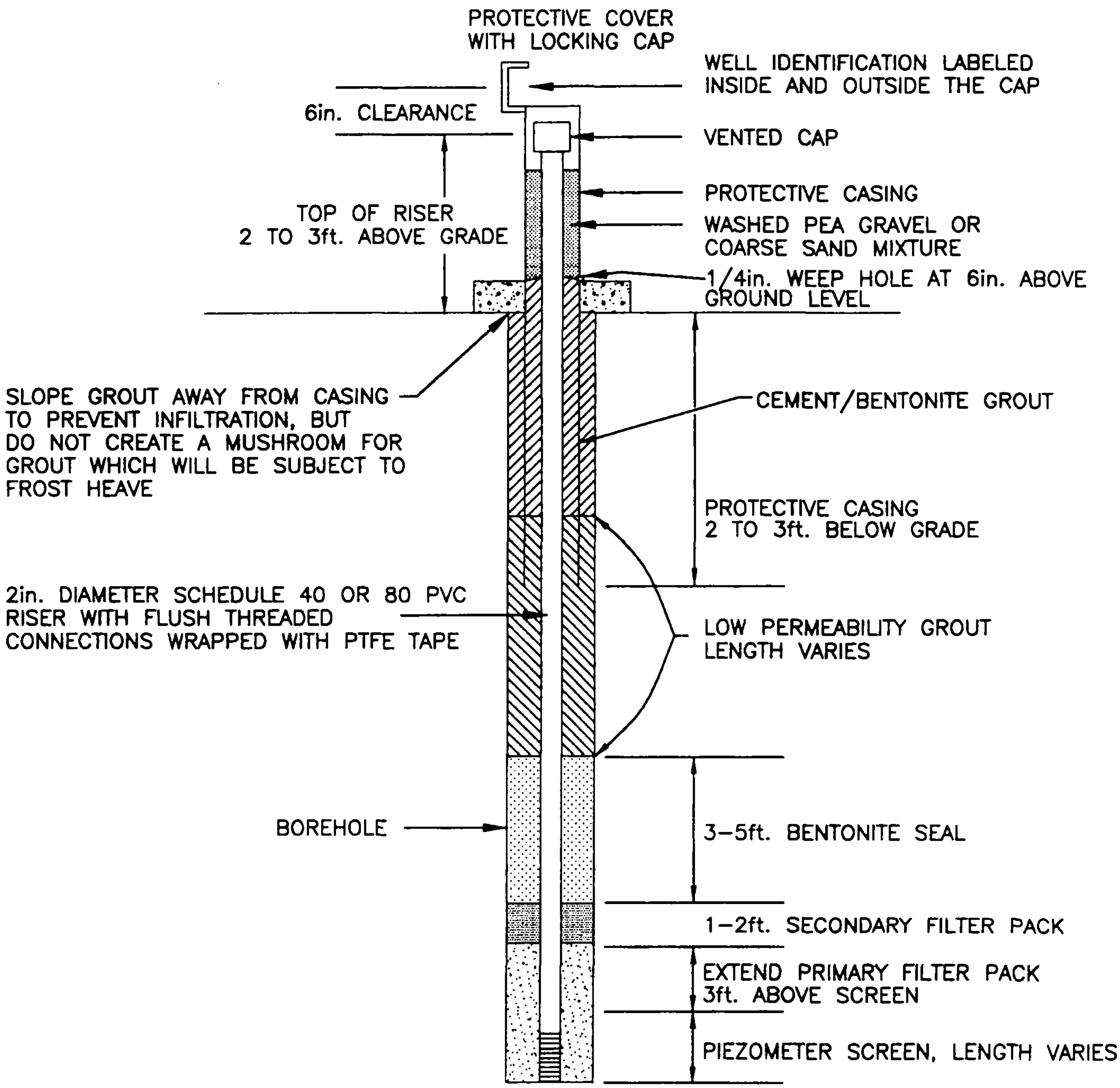
REV.	DATE	DESCRIPTION	DR. BY	APP. BY

CLIENT/PROJECT: LAIDLAW — LAIDLAW WASTE SYSTEMS INC. — WEST LAKE LANDFILL OPERABLE UNIT 2

TITLE: PROPOSED WATER LEVEL MONITORING LOCATIONS

Golder Associates — Denver, Colorado

DRAWN	TMC	DATE	APRIL 1995
CHECKED	CER	SCALE	AS SHOWN
REVIEWED	WEH	JOB NO.	943-2848
APPROVED		DWG. NO.	D003
FILE NO.	2848D003	FIGURE	6-2



Golder Associates Denver, Colorado

TITLE

TYPICAL LEACHATE RISER CONSTRUCTION DETAIL

CLIENT/PROJECT

LAIDLAW

LAIDLAW WASTE SYSTEMS INC.

DRAWN	TMC	DATE	APRIL 1995	JOB NO.	943-2848
CHECKED	CER	SCALE	AS SHOWN	DWG NO./REV. NO.	A035
REVIEWED	WEH	FILE NO.	2848A035	FIGURE NO.	6-3

7.0 SAMPLE HANDLING AND ANALYSIS

Field activities required for sampling will include collection and preservation of samples as well as packing, transportation and handling of the samples prior to receipt by the laboratory.

Analytical sample bottles will be labeled with indelible ink and placed in ice-filled (natural or "blue" ice) coolers maintained at about 4 degrees Celsius (°C) after sampling is completed. The appropriate data record sheets and chain-of-custody described in the QAPP will accompany the samples to the laboratory. Chain-of-custody documentation will be sealed in a plastic bag and taped to the lid of each cooler. Custody seals will be attached to each cooler. The samples for chemical analyses will be transported/shipped to the laboratory such that the laboratory has sufficient time to meet the EPA-recommended holding times prior to analysis. Upon completion of analyses, the remaining sample volumes will be stored at the laboratory for a period equivalent to holding times, after which they will be disposed by the laboratory.

Geotechnical samples will be labeled with indelible ink and shipped to a geotechnical laboratory for analysis. The appropriate sample tracking, request for analysis, and chain-of-custody forms will accompany the samples to the laboratory. Examples of these forms are included in Attachment I.

The types and numbers of QA/QC samples for each media are specified in Table 4-1. The types of containers, preservation requirements and holding times for analytical samples are presented in Table 7-1.

Packing, transportation and handling of samples, including chain-of-custody requirements, are discussed in detail in the QAPP.

TABLE 7-1

SAMPLING CONTAINER REQUIREMENTS, ANALYTICAL PARAMETERS, AND HOLDING TIMES

Analytical Parameters	Aqueous Samples			Soil/Sediment Samples		
	Container Type	**Preservation**	**Holding Time**	**Container Type**	**Preservation**	**Holding Time**
Volatile Organic Compounds	AG-TLS 4-40mL	Cool 40	7 days	G-TLC 4 oz	Cool 40	14 days
Semi-Volatile Organic Compounds	AG-TLC 2-1 liter	Cool 40	7 days * 40 days **	G-TLC 8 oz	Cool 40	14 days 40 days**
TAL Metals, Dissolved	P,G 1-1 liter	Cool 40 HNO_3 to pH<2	6 mos. Hg-28 days	P,G 4 oz	Cool 40	6 mos.
Total Petroleum Hydrocarbons	G-TLC 1-1 liter	Cool 40 H_2SO_4 pH<2	28 days	B/ST, G-TLC 8 oz	Cool 40	14 days
TCL Pesticides/PCBs	AG-TCL 2-1 liter	Cool 40	7 days* 40 days**	G-TLC 8 oz	Cool 40	14 days* 40 days**
TAL Cyanide	P,G 250 mL	Cool 40 NaOH to pH>12	14 days	N.A.	N.A.	N.A.
Radionuclides	P 1-1 liter	HNO_3 to pH<2	6 mos.	P 1-1 liter	N.A.	N.A.
Biological Oxygen Demand	P 1-1 liter	Cool 40	2 days	N.A.	N.A.	N.A.
TDS/TSS	P 1-1 liter	Cool 40	7 days	N.A.	N.A.	N.A.
Chloride, Sulfate, Fluoride	P 250 mL	Cool 40	28 days	N.A.	N.A.	N.A.
Nitrate + Nitrite	G 125 mL	Cool 40 H_2SO_4 pH<2	28 days	N.A.	N.A.	N.A.
COD/Ammonia	G 125 mL	Cool 40 H_2SO_4 pH<2	28 days	N.A.	N.A.	N.A.
Total Phosphorus	P,G 1-1 liter	Cool 40	28 days	N.A.	N.A.	N.A.
Sulfide	G 1-1 liter	Zinc Acetate to NaOH to pH>9	7 days	N.A.	N.A.	N.A.
Total Organic Carbon	N.A.	N.A.	N.A.	G 70 mL	Cool 40 H_2SO_4 pH<2	28 days

LEGEND:

B/ST - Brass or Steel Tube; G - Glass, AG - Amber Glass

P - Polyethylene; TLC - Teflon-lined Cap; TLS - Teflon-lined Septum;

* Extraction Holding Time ** Analysis Holding Time

8.0 DECONTAMINATION EQUIPMENT AND PROCEDURES

In general, reusable equipment, such as drilling equipment, will be decontaminated with a high pressure hot water/steam cleaner between all drilling locations during the source characterization and contaminant characterization phases. Steam cleaning will be conducted at the decontamination station, as detailed below. The steam cleaner will be filled with clean, potable water. Water collected from the decontamination procedures will be disposed of as described below.

8.1 Decontamination Station

The decontamination station (decon station) will be located near the inactive concrete batch plant as shown on Figure 1-1. The decon station will consist of a lined pad large enough to park the drill rigs on and sloped for adequate drainage. The decon pad will have plastic sheeting on three sides to prevent excess spray from leaving the pad, and the steam cleaner will be housed nearby. Water for the steam cleaner will be clean, potable water. All water draining off the pad will collect in a plastic sheeting lined sump. Water will be manually or automatically pumped from the sump into 55-gallon barrels for temporary storage. Decon water will be disposed of in the leachate retention pond.

8.2 Decontamination of Drilling Equipment

Prior to entering the site, drilling rigs and drilling equipment will be thoroughly washed with a standard commercial soap and clean water. Before initiating drilling, and between each bore-hole, the downhole drilling equipment (including augers, drill bits, drill rod and any associated tools) will be steam cleaned at the decon station. The decon water will be collected and disposed of at the leachate retention pond.

8.3 Decontamination of Sampling Equipment

In addition to the drilling equipment mentioned above, all sampling equipment will be decontaminated between each sampling location to provide representative samples. Decontamination will be performed by scrubbing all equipment with Liquinox™ or comparable solution and rinsing with tap water. After the equipment has air dried, a final rinse with distilled or deionized water will be performed. Water generated from decon procedures will be disposed in the leachate retention pond.

All cleaned or unused sampling equipment will be handled by personnel wearing clean (new) disposable latex gloves.

After the sampling equipment has been decontaminated it will be placed in clean unused plastic bags sheeting. The sampling equipment will remain in wrapping material until it is used in the field. When handling or storing the decontaminated or pre-cleaned sampling equipment, care will be taken not to impact the chemical integrity of the sampling equipment.

9.0 MANAGEMENT OF INVESTIGATION - DERIVED WASTE

Investigation - Derived Waste (IDW) will include soil cuttings, rock cuttings, groundwater, used personal protection equipment and decontamination fluids. These wastes will be managed in accordance with the guidance provided in the EPA document entitled *Management of Investigation - Derived Wastes During Site Inspections* (EPA, 1991f). The nature of the wastes (i.e., hazardous versus non-hazardous) will be assessed using available information regarding the specific wastes as well as direct observation of the IDW for discoloration, odor, or other indicators of contamination.

The IDW will be managed on-site. The following on-site disposal methods are planned:

- ▷ Soil and rock cuttings from borehole drilling:
  - Collect in drums or "roll-off"; and,
  - Dispose of at the site sanitary landfill;
- ▷ Groundwater from development and purging:
  - Collect and dispose of in the on-site leachate retention pond;
- ▷ Decontamination fluids:
  - Collect and dispose of in the on-site leachate retention pond; and,
- ▷ Decontaminated personal protective equipment and disposable sampling equipment:
  - Double bag and deposit in the site sanitary landfill.

ATTACHMENT A

STANDARD FIELD FORMS

SOIL BOREHOLE LOG

SITE NAME AND LOCATION

DRILLING METHOD:

SAMPLING METHOD:

BORING NO.

SHEET OF

DRILLING START	DRILLING FINISH
TIME	TIME
DATE	DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM ELEVATION

DRILL RIG

SURFACE CONDITIONS

ANGLE BEARING

SAMPLE HAMMER TORQUE FT.-LBS

DEPTH IN FEET (ELEVATION)	BLOWS/ 6 IN ON SAMPLER (RECOVERY)	SYMBOL	SAMPLE NUMBER AND DESCRIPTION OF MATERIAL	SAMPLER AND BIT	CASING TYPE	BLOWS/FOOT ON CASING	TEST RESULTS: WATER CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	SPCIFIC GRAVITY	OTHER TESTS

DRILLING CONTR

LOGGED BY

DATE

CHK'D BY

Printed on recycled paper

RECORD OF DRILLHOLE

Sheet of

PROJECT:
PROJECT NO:
LOCATION:

BORING METHOD:
DRILLING DATE:
DRILL RIG:

DATUM:
COORDINATES N:
AZIMUTH:

COLLAR ELEV:
E:
INCLINATION:

DEPTH SCALE (FEET)	ROCK TYPE DESCRIPTION	GRAPHIC LOG	ELEV / DEPTH (FT)	RUN NO.	CORE RECOVERY	RQD 80 60 40 20	FRACTURES PER FOOT 2 4 6 8 10	DIP wrt CORE AXIS 0 30 60 90	TYPE AND SURFACE DESCRIPTION	GRAPHIC LOG	WEATHERING INDEX SW FR MW HW CW	STRENGTH INDEX R6 R5 R4 R3 R2 R1	POINT LOAD INDEX (psi) R1 30 R2 150 R3 300 R4 600 R5 1500 R6	TEST ORIENTATION	NOTES WATER LEVELS INSTRUMENTATION
0															
2															
4															
6															
8															
10															
12															
14															
16															

J-Joint, F-Fault, S-Shear, B-Bedding, F-Foliation
PL-Planar, C-Curved, U-Undulating, ST-Stepped, I-Irregular
P-Polished, K-Slikensided, SM-Smooth, R-Rough, VR-V. Rough

DISCONTINUITY DATA

DEPTH SCALE:
DRILLING CONTRACTOR:
DRILLER:

LOGGED:
CHECKED:
DATE:

Golder Associates

Well No. ____________

Boring No. X-Ref: ____________

PIEZOMETER CONSTRUCTION SUMMARY

Survey Coords: ____________ Elevation Ground Level ______ ______

Top of PVC Casing ____________

Drilling Summary:

Total Depth ____________

Borehole Diameter ____________

Casing Stickup Height ____________

Driller ____________

Rig ____________

Bit(s) ____________

Drilling Fluid ____________

Protective Casing ____________

Construction Time log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling				
Geophys.Logging				
Casing:				
Filter Placement:				
Cementing:				
Development				
Volclay Grout				
Bentonite Seal				

Well Design & Specifications

Basis: Geologic Log X Geophysical Log ______

Casing string(s): C = Casing S = Screen

Depth		String(s)	Elevation	
+ 0.00 -			-	
-			-	
-			-	
-			-	
-			-	
-			-	

Casing: C1 ____________

C2 ____________

Screen: S1 ____________

Filter Pack: ____________

Grout Seal: ____________

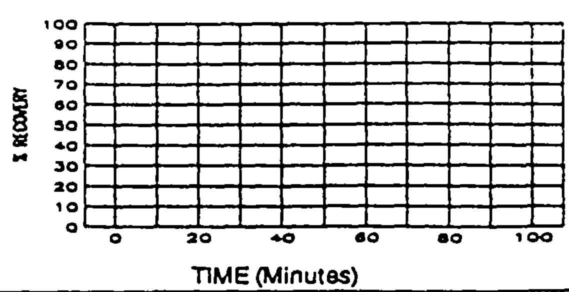
Bentonite Seal: ____________

Well Development

Stabilization Test Data:

Time number	pH	Spec. Cond.	Temp (°C)

Recovery Data:



Comments: ____________

Supervised by B. Tilton Site ____________

Job Number ____________ File Name ____________

PRESSURE PACKER TEST READINGS

TYPE OF PACKER: SINGLE, DOUBLE.

BOREHOLE DIA. (core size) ---------

GAUGE HEIGHT (above G.S.) --------- ft.

DEPTH TO W.L. (stabilized) --------- ft.

DEPTH OF TEST ----- TO ------- ft.

DATE: -----------

ENGINEER -------------------

CORE DESCRIPTION ---------------

APPLIED PRESSURE (p.s.i)	TIME (min.)	METER (gal.)	Δ TAKE (gal.)	TOTAL TAKE (gal.)

APPLIED PRESSURE (p.s.i)	TIME (min.)	METER (gal.)	Δ TAKE (gal.)	TOTAL TAKE (gal.)

REMARKS: (re. core description, unstable pressure, leakage, etc.)

JOB No. -------------

BOREHOLE ------------

DEPTH ----- TO -----

SHEET -------------

Golder Associates

FORM G.A.- F- 6a

PRESSURE PACKER TEST CALCULATION

TYPE OF PACKER: SINGLE, DOUBLE

BOREHOLE DIA. (core size) __________

DEPTH TO W.L. (stabilized) ________ ft.

DATE: __________

ENGINEER ________________

PRESSURE, p.s.i. _____

Q = _______ gal./min.

PRESSURE, p.s.i. ______

Q = ______ gal./min.

PRESSURE, p.s.i. _____

Q = _______ gal./min.

PRESSURE, p.s.i. ____

Q = ______ gal./min.

CUMULATIVE TAKE, gal.

PRESSURE, p.s.i.

Q, gal./min.

COMPUTATIONS:

JOB No. ______________

BOREHOLE ______________

DEPTH _____ TO _____

SHEET ______________

Golder Associates

Slug Test - Field Record

Project No.: ______ Date: ______

Tested by: ______

Hole No.: ______ Test No.: ______

Description * ______

Description * ______

Hole Diameter ______ m cm ft in Angle¹ : ______

Length Tested ______ m cm ft in

Stem² Diameter ______ m cm ft in

Reading Type: Depth Pressure

Reading Units: m cm kPa ft in psi Accuracy* : ______

Datum Reading* :

Elevation: ______ m cm ft in

Reading: ______ S W L ³

Anisotropy Factor* : $m = \sqrt{(kv/kh)}$ = ______

Notes

Collar elevation ______

Total depth of hole ______

Height of collar above point at which depth is measured ______

Depth to top of test interval ______

Depth to bottom of test interval ______

Depth to SWL before test ______

Depth to SWL after test ______

Bubbler reading in air ______

Bubbler depth ______

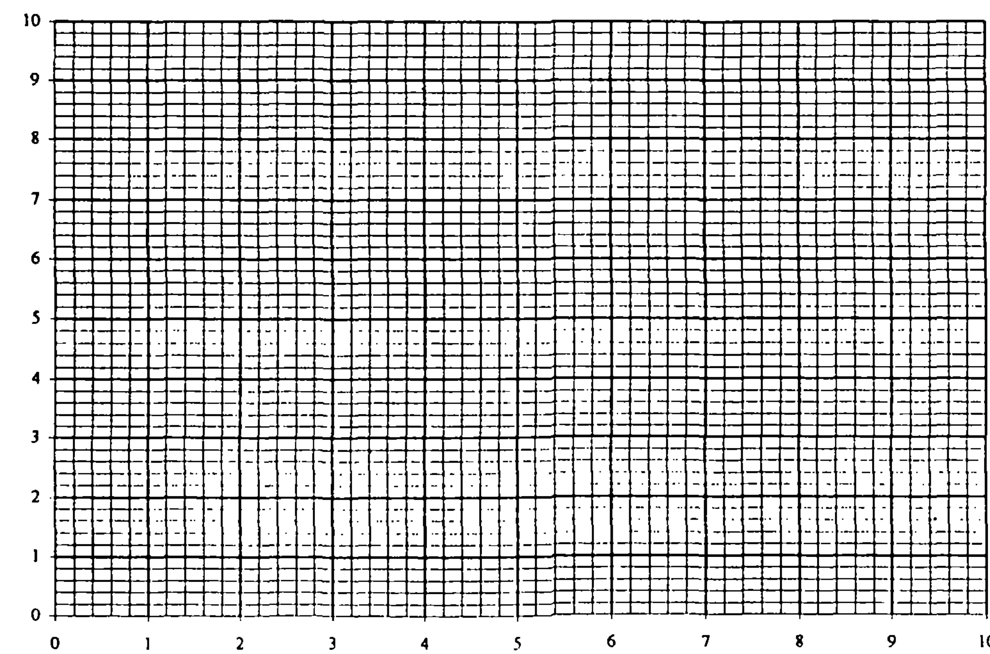
Volume of water added ______

Height of water added ______

Clock time at start of test ______

* *Optional item*
¹ *Angle is the deviation of the hole from the vertical*
² *The STEM is the tube, rod or casing in which the level is falling*
³ *Circle SWL if the datum reading is the static water level*

Time (minutes)	Reading	Time (minutes)	Reading	Time (minutes)	Reading



Slug Test - Field Record

Time (minutes)	Reading minus S W L rdg

Basic Formulae (convert data to common unit length)

FLOW, Q $\quad Q = C\,h\,k$

FACTOR, C $\quad C = \dfrac{2\pi L}{\ln(2mL/D)}$

PERMEABILITY, k $\quad k = \dfrac{\pi d^2 (\Delta h/\Delta t)}{4\,C\,h}$

BACKGROUND HEAD, h_b $\quad h_b = \dfrac{H_1 H_3 - H_2^2}{H_1 + H_3 - 2H_2}$

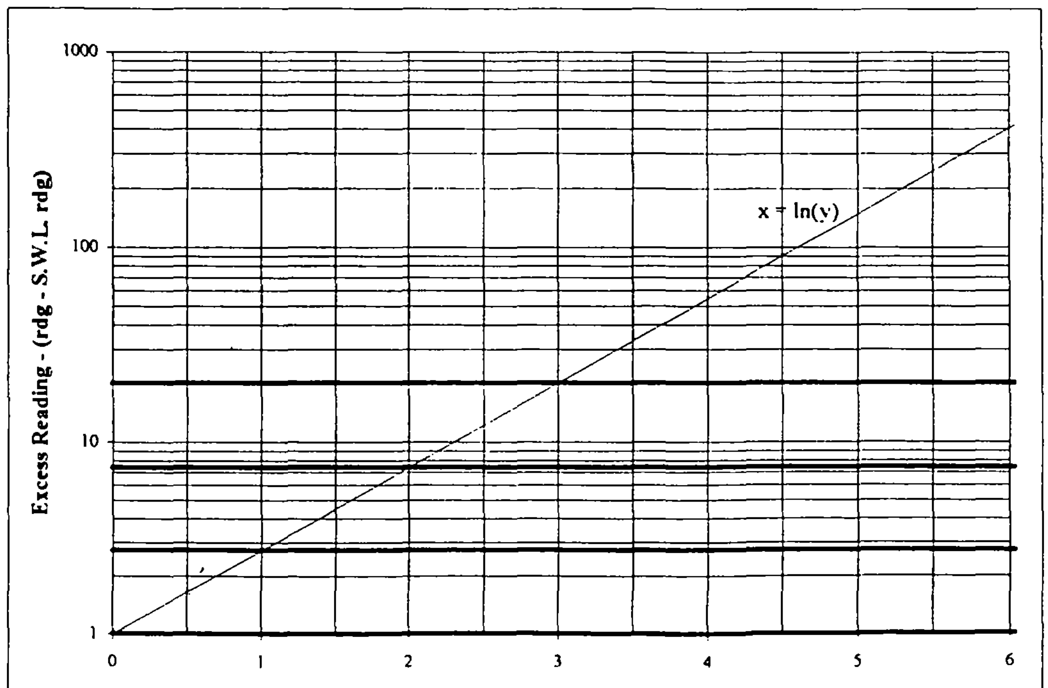
L = Length tested
h = Head - background head
k = Horizontal permeability
m = Anisotropy Factor, usually 1.0
D = Diameter of hole
d = Stem diameter

(H1, H2 and H3 are heads at equal consecutive time steps)

Hvorslev Method

$$k = \frac{d^2 \ln(2mL/D)}{8LT}$$

T = time interval for excess reading to decay by 63%
= time for the excess reading to drop from one bold line to the next bold line



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Well Purging and Recovery

Sheet 1 of ____

Location

Monitored by: Date: Time:

Well/Piezometer Data

(circle one)

Depth of well (from top of PVC or ground) ____ feet

Depth to water (from top of PVC or ground) ____ feet

Radius of casing ____ inches
____ feet

Casing Volume ____ cubic feet
____ gallons

Development/Purging Discharge Data

Purging method

Start Purging Date: Time:

Stop Purging Date: Time:

Monitoring

Date	Time	Volume discharged (gals)	Temp (°F)	pH	Spec.Cond. (mS/cm)	Turbidity (NTU)	Appearance of water and comments

Water Level Recovery Data

Start of recovery Date: Time:

Monitoring

Date	Clock Time (hh:mm)	Elapsed time (mins)	Water Level (feet) Measurement point: ____

Golder Associates

Well Purging and Recovery

Continued

Location

Monitored by:

Water Level Recovery Data - Second Sheet

Start of recovery Date: Time:

Monitoring

Date	Clock Time (hh:mm)	Elapsed time (mins)	Water Level (feet) Measurement point:

WATER LEVEL DATA

WELL LOCATION ______________________________ MEASURING POINT ______________________________

ELEVATION: MEASURING POINT ______________________ GROUND LEVEL ______________________

WELL or DATE	TIME	MEASURING DEVICE	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL		BY	COMMENTS
					DEPTH	ELEVATION		

LOCATION ______________

PROJECT ______________

Golder Associates

Sample Tracking Form

Date	Time	Location	Sample No.	Medium	Analysis/Method	Chain of Custody No.	Lab	Date Shipped	Comments

SAMPTRAC.XLS

CHAIN OF CUSTODY RECORD

PROJ. NO.	SITE / LOCATION

SAMPLERS: *(Signature)*

STA. NO.	DATE	TIME	SAMPLE TYPE	MEDIA	SAMPLE IDENTIFICATION	NO. OF CONTAINERS	AMOUNT/ PRESERVATIVE						SEAL NO.	SEAL INTACT? (Y or N)	REMARKS (with initials)

Relinquished by: *(Signature/Firm)*	Date / Time	Received by: *(Signature/Firm)*	Relinquished by: *(Signature/Firm)*	Date / Time	Received by: *(Signature/Firm)*
Relinquished by: *(Signature/Firm)*	Date / Time	Received by: *(Signature/Firm)*	Relinquished by: *(Signature/Firm)*	Date / Time	Received by: *(Signature/Firm)*
Relinquished by: *(Signature/Firm)*	Date / Time	Received by: *(Signature/Firm)*	Date / Time	Remarks (attachments if necessary)	

Sample Integrity Data Form

Date	Time	Sampled by:	Location	Sample No.	Medium	Analysis/Method	Chain of Custody No.	Lab	Date Shipped	Comments

Golder Associates

Instrument Calibration Form

Calibration by:		Date:	
		Time:	

Instrument Details

Instrument Name	
Serial No.	
Model No.	

Calibration Details

Required Calibration Frequency/Last Calibration	
Calibration Standard	
Calibration Standard(s) expiration date	

Calibration:

Calibration Standard Units: ______	Instrument Reading Units: ______

Comments:

CALIBFRM.XLS

Golder Associates Inc.

AIR MONITORING DATA SHEET

Date ____________ Sheet _____ of _____

Job Name ______________________________________ Job Number ______________

Location ____

Time In ________ Time Out __________ Weather ______________ Temp. ______ Wind D. _____ V ______

Instrument Type ______________________________ Serial No. ______________

Calibration Gas and Concentration ______________ Instrument Reading ____________ Span/Gain/RF Setting __________

* If more than one instrument is used, document calibration procedures and results for each additional instrument in recommendations section below and indicate the instrument used (eg. OVA, 361, OVM, etc.) for each observation.

Time	Station	Instr. *	Reading	Procedure/Observations/Comments

Recommendations

____

____

____

____

____

Printed Name ____________________ Signature ____________________

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN

APPENDIX A-2
DRAFT
QUALITY ASSURANCE PROJECT PLAN

WEST LAKE LANDFILL
OPERABLE UNIT 2
BRIDGETON, MISSOURI

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1.0 INTRODUCTION

This document is the Quality Assurance Project Plan (QAPP) for the Remedial Investigation/Feasibility Study (RI/FS) of Operable Unit 2 (OU-2) at the West Lake Landfill. Laidlaw Waste Systems, Inc. (Laidlaw) has retained Golder Associates Inc. (Golder) to conduct the RI/FS of OU-2 at the site. The RI/FS will be conducted pursuant to an *Administrative Order on Consent* (AOC) issued by the Environmental Protection Agency (EPA), Region VII, CERCLA Docket No. VII-94-F-0025.

The QAPP is an element of the Sampling Analysis Plan (SAP) which, in turn, is an element of the OU-2 RI/FS Work Plan. The QAPP was prepared specifically for the OU-2 RI/FS Work Plan and is intended to be used in conjunction with the Field Sampling Plan (FSP), also an element of the SAP. The SAP represents Appendix A of the OU-2 RI/FS Work Plan; the FSP is Appendix A-1 and the QAPP is Appendix A-2.

The SAP has been prepared in accordance with EPA guidance provided in:

- *Guidance For Conducting Remedial Investigations Under CERCLA (Interim Final)* (EPA, 1988f);
- *Conductivity Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (EPA, 1991);
- *Presumptive Remedy for CERCLA Municipal Landfill Sites* (EPA, 1993a); and,
- *Streamlining the RI/FS at CERCLA Municipal Landfill Sites* (EPA, 1990).

This QAPP has been developed in accordance with EPA guidance provided in *Preparation Aids for the Development of Category 1: Quality Assurance Project Plans* (EPA, 1991), and *Preparing Perfect Project Plans* (EPA, 1989). References cited in this QAPP are listed in Section 8.0 of the OU-2 Work Plan.

2.0 PROJECT DESCRIPTION

2.1 Remedial Investigation Objectives

The primary objectives of the West Lake Landfill OU-2 RI are to:

- Collect data on and adjacent to OU-2 regarding environmental characteristics, potential chemical migration pathways and transport mechanisms;
- Assess the potential risk to human health and the environment resulting from actual or potential releases from the site; and,
- Conduct treatability testing as necessary to support the evaluation of proposed remedies.

In addition, information collected from the RI will be incorporated into the design of the ground water monitoring system for the currently operating Bridgeton Landfill.

2.2 Quality Assurance Project Plan Objectives

The objective of the Quality Assurance Project Plan (QAPP) is to describe the policy, organization, functional activities, and quality assurance and quality control (QA/QC) protocols necessary to achieve the data quality objectives (DQOs) dictated by the intended use of the data. In addition, the QAPP addresses sampling procedures, sample custody, analytical procedures, and data reduction, validation, reporting, and personnel qualifications. This QAPP applies specifically to the field activities and laboratory analyses and procedures performed as part of the remedial investigation in and near OU-2 of the West Lake Landfill site.

2.3 Site Description

The following historical operations summary was derived from the OU-2 Work Plan. Complete details of the site operational history are provided in Section 2.5 of the OU-2 Work Plan. A site map is provided in Figure 2-1.

The site was used for agricultural purposes until 1939, when limestone quarrying operations were initiated in the eastern portion of the site. Quarrying continued until economically-recoverable reserves were exhausted in 1988. Mine spoils were deposited on adjacent land immediately to the west of the quarry, within the OU-2 study area. Limestone, concrete, and asphalt processing was conducted on-site during quarry operations; asphalt and concrete activities continue to date. The processing operations were conducted primarily in the central portion of the facility. Concrete processing was conducted in the central and northern portion.

Based on available data, solid waste disposal may have begun at the site as early as 1952, although many sources cite 1962 as the initiation date for waste disposal. Waste disposal in Missouri was regulated solely by St. Louis County authorities until 1974, when the Missouri Department of Natural Resources (MDNR) was formed. At the West Lake Landfill site, the MDNR closed certain waste disposal sites on the northern portion of the site and issued State permits for disposal of sanitary and demolition wastes in other areas. Waste disposal continued during and after cessation of mining activities, using the quarry pits as landfill cells. The MDNR permit areas are highlighted on Figure 2-4 of the Work Plan and discussed in detail in Work Plan Section 2.4.3.2.

Radiological wastes consisting of 700 tons of uranium contained in 8,700 tons of barium sulfate, and mixed with 39,000 tons of soil, were reportedly disposed of in two portions of the site in 1973, now comprising OU-1 (Areas 1 and 2, Figure 2-1). The site was placed on the National

Priorities List (NPL) in 1990, based primarily on the presence of radiological isotopes and the associated potential for groundwater contamination. Operable Unit 1 is being characterized under *Administrative Order on Consent*, Docket No. VII-93-F-0005 (EPA, 1993b).

To date, OU-1 activities have included preparation of an RI/FS Work Plan and associated documents (McLaren/Hart, 1994a), as well as completion of an overland gamma survey designed to identify the extent of radiological contamination within and near OU-1 Areas 1 and 2.

Characterization of OU-2 is the subject of the OU-2 RI/FS Work Plan. As previously stated, this QAPP supports the tasks described in the Work Plan.

2.4 Remedial Investigation Tasks

The OU-2 RI field investigation will include the following tasks:

- Define site physical and biological characteristics:
  - Surficial geologic investigation;
  - Ecological evaluation; and,
  - Collection of additional information on site physical characteristics and demographics.
- Characterize site hydrogeologic characteristics:
  - Evaluation of existing well integrity;
  - Initial hydrogeologic investigation; and,
  - Determine groundwater quality.
- Define sources of contamination:
  - Leachate sampling and analysis;
  - Landfill gas characterization;
  - Investigation of potential petroleum impacts near well MW-F2; and,
  - Evaluation of potential impacts to groundwater.

- Determine surface water and sediment quality:
  - Surface water sampling and analysis; and,
  - Seep survey, sampling, and analysis.
- Determine air quality.

The OU-2 FS data collection activities will include:

- Geotechnical Landfill Cap Investigation
  - Cap thickness and geotechnical analysis.

The quality assurance plan necessary to ensure that data obtained from these activities is described in this QAPP. All investigative activities and methodologies are discussed in detail in Section 2 of the FSP.

2.5 Project Schedule

Preliminary studies and field activities for the RI were initiated in January 1995. The field investigation is anticipated to last until October 1996. The field investigation schedule is detailed in the FSP. The complete RI/FS schedule is provided in Figure 6-1 of the Work Plan.

2.6 Analytical Parameters and Sampling Frequency

Previous site investigations indicate the potential presence of chemical compounds, metals, and radionuclides in environmental media at the West Lake Landfill. The chemicals of concern for OU-2 include: volatile organic compounds (VOCs), non-volatile (semi-volatile) organic compounds (SVOCs), petroleum hydrocarbons, pesticides, polychlorinated biphenyls (PCBs), metals, and cyanide. In addition, radionuclides (uranium-234, uranium-235, uranium-238, thorium-230, and radium-226) have been included as chemicals of concern for groundwater because of the potential for contaminant migration from OU-1. Sample matrices and frequencies of sample collection are specified in Table 2-1. Analytical parameters are specified in Tables 2-2 through 2-6.

The anticipated analytical methods and detection limits which will be used for sample analysis during the RI are identified in Tables 2-2 through 2-6. The detection limits for groundwater, surface water, soils, and gas are based on the lower of maximum concentration limits (MCLs), maximum concentration limit goals (MCLGs), or EPA Region III risk-based concentrations (RBC) (EPA, 1994a). The RBCs follow Federal guidance and are accepted as detection limits in other EPA regions. Actual analytical methods will be determined by the appropriate health-based criteria, and will be submitted to the EPA as an addendum to the QAPP.

Groundwater analyses will include the following AOC- and SOW-defined parameters:

- Page 11 of the SOW (Attachment II to the AOC) identifies the following general categories of "chemicals of concern":
  - Volatile organic compounds;
  - Non-volatile (semi-volatile) organic compounds;
  - Total petroleum hydrocarbons;
  - Pesticides;
  - Polychlorinated biphenyls;
  - Metals;
  - Radionuclides; and,
  - Cyanides.
- Pages 5 and 6 of the AOC identify the following specific compounds as having been detected in previous sampling events at the site:
  - Methylene chloride;
  - 2-ethylhexyl phthalate;

- Phenol;
- Total cyanide;
- Lead;
- Zinc;
- Lindane;
- Chlordane;
- Dieldrin;
- Endrin;
- 4,4'-DDD (dichlorodiphenyldichloroethane);
- 4,4'-DDE (4,4' dichlorodiphenyltrichloroethene);
- 4,4'-DDT (4,4' dichlorodiphenyltrichloroethane);
- Hexachlorobenzene;
- Arsenic;
- Antimony;
- Nickel; and,
- Thallium.

Methylene chloride and acetone, two common laboratory artifacts, were also present in laboratory QC blanks.

Other aqueous samples (leachate, seeps, and surface water) will be analyzed for:

- Volatile organic compounds;
- Non-volatile (semi-volatile) organic compounds;
- Total petroleum hydrocarbons;
- Pesticides;
- Polychlorinated biphenyls;
- Metals; and,
- Cyanides.

Additionally, certain groundwater and leachate samples collected as part of the hydrocarbon investigation near MW-F2 will also be analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX).

Solids samples (soil and sediments) will be analyzed for:

- Volatile organic compounds;
- Semi-volatile organic compounds;
- Total petroleum hydrocarbons;
- Pesticides;
- Polychlorinated biphenyls;
- Metals; and,
- Cyanides.

Additionally, soils samples collected during installation of alluvial piezometers will be analyzed for total organic carbon (TOC) in order to model potential organic contaminant migration. Selected soil samples collected from boring near MW-F2 will be analyzed for benzene, toluene, ethylbenzene, and xylenes.

Landfill gas will be analyzed for VOCs and methane. Soil gas will be analyzed for VOCs.

2.7 Analytical Data Levels

Analytical data will be obtained at three different levels, based on criteria provided in *Data Quality Objectives for Remedial Response Activities: Volume 1, Development Process*, (EPA, 1987a), as described below:

Level I - Field Screening - This level is characterized by the use of portable instruments, such as a photoionization detector (PID) or explosimeter (Combustible Gas Indicator), that can provide real-time data to assist in the optimization of samples for laboratory analysis and for health and safety monitoring. Qualitative data can be generated regarding the presence or absence of certain types of contaminants (i.e., volatile organics) at sampling locations. Results are generally not chemical specific and are not quantitative. Air monitoring using a PID and explosimeter will be conducted on-site under Level I.

Level II - Field Analyses - This level uses more sophisticated portable analytical instruments, whether on-site or in a mobile laboratory. Qualitative and quantitative data can be generated for certain compounds depending on the type of contaminant, the sample matrix, and the analytical procedures. Level II measurements of soil head space, pH, turbidity, specific conductivity, and temperature will be conducted on-site during sampling.

Level III - Laboratory Analyses - This level refers to analyses conducted by standard, documented laboratory procedures in a laboratory. Level III analyses may be performed under non-contract laboratory program guidelines. This Level will be used for analysis of compounds specified in Tables 2-2 through 2-6 in samples collected for laboratory chemical analysis during the West Lake Landfill OU-2 RI.

TABLE 2-1

ESTIMATED NUMBER OF INVESTIGATIVE AND QA/QC SAMPLES

SAMPLE MEDIA	NUMBER OF INVESTIGATIVE SAMPLES	NUMBER OF EQUIPMENT RINSATES	NUMBER OF FIELD DUPLICATES
Groundwater			
- Round 1	Reserved	Reserved	Reserved
- Round 2	Reserved	Reserved	Reserved
Surface Water			
- Seeps	As necessary	1 per 10 or fewer investigative samples	1 per 10 or fewer investigative samples
- Earth City Storm Water Retention Ponds***	2	1	1
Sediment			
- Seeps	As necessary	1 per 10 or fewer investigative samples	1 per 10 or fewer investigative samples
- Earth City Storm Water Retention Ponds***	2	1	1
Leachate	6		1
Landfill Gas	20	2	2
Soil Gas	4	1	1
Subsurface Soil (TOC)	24	0	0

* If dedicated or disposable sampling equipment is used for groundwater sampling, no equipment rinsates will be collected.

** The number of groundwater investigative samples collected will be determined based on hydrogeologic characterization data. The wells to be sampled will be selected and communicated to the EPA in a monthly report or technical memorandum for EPA's approval.

*** Includes one background sample.

TABLE 2-2

AQUEOUS SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1] Groundwater	HEALTH-BASED CRITERIA[2] Limit	Unit
RCRA SUBTITLE D APPENDIX I METALS			
Antimony	7041	6	ug/l
Arsenic	7060	3.8	ug/l
Barium	6010	2000	ug/l
Beryllium	6010	1.6	ug/l
Nickel	6010	100	ug/l
Selenium	7740	50	ug/l
Silver	6010	180	ug/l
Sodium	6010	-	-
Thallium	7841	2	ug/l
Vanadium	6010	260	ug/l
Zinc	6010	5000	ug/l
CONVENTIONALS			
Ammonia as Nitrogen	350.1	-	-
Boron	6010	3300	ug/l
Cadmium	6010	5	ug/l
Calcium	6010	-	-
Chemical Oxygen Demand (COD)	410.4	-	-
Chloride	325.2	250	mg/l
Chromium	6010	100	ug/l
Cobalt	6010	6600	ug/l
Copper	6010	1000	ug/l
Cyanide, Total	9010	200	ug/l
Fluoride	340.2	-	-
Hardness, Total (Calculated)	130.2	-	-
Iron	6010	-	-
Lead	7421	-	-
Magnesium	6010	-	-
Manganese	6010	-	-
Mercury	7470	2	ug/l
Nitrate/Nitrite	353	10	mg/l
Phosphorus, Total	365.2	-	-
Sulfate as SO_4	375.4	250	mg/l
Sulfide	9030	-	-
Total Dissolved Solids (TDS)	160.1	500	mg/l
Total Organic Carbon (TOC)	415.1	-	-
Total Petroleum Hydrocarbons	8015M	-	-
FIELD MEASUREMENTS			
pH (Field)	150.1	-	-
Specific Conductance (Field)	120.1	-	-
Groundwater Elevation	Field	-	-
Temperature	Field	-	-
RCRA SUBTITLE D APPENDIX I VOLATILE ORGANIC COMPOUNDS			
Acetone	8260	3700.0	ug/l
Acrylonitrile	8260	12.0	ug/l
Benzene	8260	5.0	ug/l
Bromochloromethane	8260	-	-
Bromodichloromethane	8260	17.0	ug/l
Bromoform (Tribromomethane)	8260	100.0	ug/l
Bromomethane (Methyl bromide)	8260	8.7	ug/l
Carbon disulfide	8260	21.0	ug/l
Carbon tetrachloride	8260	5.0	ug/l
Chlorobenzene	8260	39.0	ug/l
Chloroethane	8260	8600.0	ug/l
Chloroform (Trichloromethane)	8260	15.0	ug/l
Chloromethane (Methyl chloride)	8260	140.0	ug/l
1,2-Dibromo-3-chloropropane	8260	4.8	ug/l
Dibromochloromethane	8260	13.0	ug/l
1,2-Dibromoethane (Ethylene dibromide)	8260	0.075	ug/l
trans-1,4-Dichloro-2-butene	8260	-	-

Footnotes provided on page 4

TABLE 2-2

AQUEOUS SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1] Groundwater	HEALTH-BASED CRITERIA[2] Limit	Unit
1,2-Dichlorobenzene (o-DCB)	8260	370.0	ug/l
1,4-Dichlorobenzene (p-DCB)	8260	44.0	ug/l
1,1-Dichloroethane	8260	810.0	ug/l
1,2-Dichloroethane	8260	5.0	ug/l
1,1-Dichloroethene	8260	4.4	ug/l
cis-1,2-Dichloroethene	8260	61.0	ug/l
trans-1,2-Dichloroethene	8260	100.0	ug/l
1,2-Dichloropropane	8260	5.0	ug/l
cis-1,3-Dichloropropene	8260	-	-
trans-1,3-Dichloropropene	8260	-	-
Ethylbenzene	8260	700.0	ug/l
2-Hexanone	8260	-	-
Methyl ethyl ketone (2-Butanone)	8260	22000.0	ug/l
Methyl iodide (Iodomethane)	8260	-	-
Methyl isobutyl ketone (4-Methyl-2-pentanone)	8260	2900.0	ug/l
Methylene bromide	8260	61.0	ug/l
Methylene chloride	8260	5.0	ug/l
Styrene	8260	100.0	ug/l
1,1,1,2-Tetrachloroethane	8260	41.0	ug/l
1,1,2,2-Tetrachloroethane	8260	5.2	ug/l
Tetrachloroethene	8260	5.0	ug/l
Toluene	8260	750.0	ug/l
1,1,1-Trichloroethane	8260	200.0	ug/l
1,1,2-Trichloroethane	8260	5.0	ug/l
Trichloroethene	8260	5.0	ug/l
Trichlorofluoromethane (Freon 11)	8260	1300.0	ug/l
1,2,3-Trichloropropane	8260	0.15	ug/l
Vinyl acetate	8260	37000.0	ug/l
Vinyl chloride	8260	1.9	ug/l
Xylenes	8260	10000.0	ug/l
TCL SEMIVOLATILE ORGANIC COMPOUNDS			
Acenaphthene	8270	2200.0	ug/l
Acenaphthylene	8270	-	-
Anthracene	8270	11000	ug/l
Benzo(a)anthracene	8270	9.2	ug/l
Benzo(a)pyrene	8270	0.2	ug/l
Benzo(b)fluoranthene	8270	9.2	ug/l
Benzo(ghi)perylene	8270	-	-
Benzo(k)fluoranthene	8270	92	ug/l
4-Bromophenyl phenyl ether	8270	2100	ug/l
Butyl benzyl phthalate	8270	7300	ug/l
Carbazole	8270	-	-
p-Chloro-m-cresol	8270	-	-
4-Chloroaniline	8270	150	ug/l
bis(2-Chloroethoxy)methane	8270	-	-
bis(2-Chloroethyl)ether	8270	0.92	ug/l
bis(2-Chloroisopropyl)ether	8270	96	ug/l
2-Chloronaphthalene	8270	2900	ug/l
2-Chlorophenol	8270	180	ug/l
4-Chlorophenyl phenyl ether	8270	-	-
Chrysene	8270	920	ug/l
m-Cresol	8270	1800	ug/l
o-Cresol	8270	1800	ug/l
p-Cresol	8270	180	ug/l
Dibenzo(a,h)anthracene	8270	0.92	ug/l
Dibenzofuran	8270	-	-
3,3'-Dichlorobenzidine	8270	15	ug/l
2,4-Dichlorophenol	8270	110	ug/l
Diethyl phthalate	8270	29000	ug/l
Dimethyl phthalate	8270	370000	ug/l
2,4-Dimethylphenol	8270	730	ug/l
Di-*n*-butyl phthalate	8270	3700	ug/l

Footnotes provided on page 4

TABLE 2-2

AQUEOUS SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1] Groundwater	HEALTH-BASED CRITERIA[2] Limit	Unit
4,6-Dinitro-o-cresol	8270	-	-
2,4-Dinitrophenol	8270	73	ug/l
2,4-Dinitrotoluene	8270	73	ug/l
2,6-Dinitrotoluene	8270	37	ug/l
Di-n-octyl phthalate	8270	730	ug/l
bis(2-Ethylhexyl) phthalate	8270	6	ug/l
Fluoranthene	8270	1500	ug/l
Fluorene	8270	1500	ug/l
Hexachlorobenzene	8270	0.66	ug/l
Hexachlorobutadiene	8270	14	ug/l
Hexachlorocyclopentadiene	8270	0.15	ug/l
Hexachloroethane	8270	75	ug/l
Indeno(1,2,3-cd)pyrene	8270	9.2	ug/l
Isophorone	8270	7100	ug/l
2-Methylnaphthalene	8270	-	-
Naphthalene	8270	1500	ug/l
2-Nitroaniline	8270	2.2	ug/l
3-Nitroaniline	8270	110	ug/l
4-Nitroaniline	8270	110	ug/l
Nitrobenzene	8270	3.4	ug/l
2-Nitrophenol	8270	-	-
4-Nitrophenol	8270	2300	ug/l
N-Nitrosodi-n-propylamine	8270	0.96	ug/l
N-Nitrosodiphenylamine	8270	1400	ug/l
Pentachlorophenol	8270	1	ug/l
Phenanthrene	8270	-	-
Phenol	8270	22000	ug/l
Pyrene	8270	1100	ug/l
1,2,4-Trichlorobenzene	8270	70	ug/l
2,4,5-Trichlorophenol	8270	3700	ug/l
2,4,6-Trichlorophenol	8270	610	ug/l
TCL PESTICIDES & PCBs			
Aldrin	8080	0.4	ug/l
alpha-BHC	8080	1.1	ug/l
beta-BHC	8080	3.7	ug/l
delta-BHC	8080	-	-
gamma-BHC (Lindane)	8080	0.2	ug/l
alpha-Chlordane	8080	2	ug/l
gamma-Chlordane	8080	2	ug/l
4,4'-DDD	8080	20	ug/l
4,4'-DDE	8080	20	ug/l
4,4'-DDT	8080	20	ug/l
Dieldrin	8080	0.42	ug/l
Endosulfan I	8080	-	-
Endosulfan II	8080	-	-
Endosulfan sulfate	8080	-	-
Endrin	8080	0.2	ug/l
Endrin aldehyde	8080	-	-
Endrin ketone	8080	-	-
Heptachlor	8080	0.23	ug/l
Heptachlor epoxide	8080	0.12	ug/l
Methoxychlor	8080	40	ug/l
Toxaphene	8080	3	ug/l
Aroclor-1016	8080	0.5	ug/l
Aroclor-1221	8080	0.5	ug/l
Aroclor-1232	8080	0.5	ug/l
Aroclor-1242	8080	0.5	ug/l
Aroclor-1248	8080	0.5	ug/l

Footnotes provided on page 4

TABLE 2-2

AQUEOUS SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1] Groundwater	HEALTH-BASED CRITERIA[2]	
		Limit	Unit
Aroclor-1254	8080	0.5	ug/l
Aroclor-1260	8080	0.5	ug/l

NOTES:
1. Analytical methods may be determined by the actual concentration detected and the health-based criteria.
2. Health-based criteria will be used as detection limits for groundwater and surface water samples, and do not apply to leachate or seep samples. Actual quantitation limits provided by the laboratory will be equal to or less than the health-based criteria. The actual quantitation limits will be provided by the laboratory in the addendum to the QAPP.

- : Not applicable.
ug/L: micrograms per liter
mg/L: milligrams per liter
Groundwater samples will be analyzed for total and dissolved metals constituents.
Leachate and surface water samples will be analyzed for total metals constituents.
PCBs = Polychlorinated Biphenyls.
TCL = Target Compound List.

TABLE 2-3

GROUNDWATER SAMPLE RADIONUCLIDE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA	
		LIMIT	UNITS
Gross Alpha, Total and Dissolved	9310	5	pCi/L
Gross Beta, Total and Dissolved	9310	1	--
Radium-226, Total and Dissolved	9315A	5	pCi/L
Thorium-230, Total and Dissolved	U-NAS-NS-3050	82.7	pCi/L
Uranium-234, 235, and 238, Total and Dissolved	U-NAS-NS-3050	30	pCi/L

NOTES:

pCi/L = pico curies per liter

-- : Not applicable

1. Analytical methods may be determined by actual concentrations detected and the health-based criteria.
2. Actual quantitation limits provided by the laboratory will be equal to or less than the health-based criteria. The actual quantitation limits will be provided by the laboratory in the addendum to the QAPP.

TABLE 2-4

SEDIMENT SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA LIMITS[2]	
		Limit	Units
RCRA SUBTITLE D APPENDIX I METALS			
Antimony	7041	410	mg/kg
Arsenic	7060	160	mg/kg
Barium	6010	72000	mg/kg
Beryllium	6010	67	mg/kg
Cadmium	6010	510	mg/kg
Chromium	6010	5100	mg/kg
Cobalt	6010	180000	mg/kg
Copper	6010	38000	mg/kg
Lead	7421	-	-
Nickel	6010	20000	mg/kg
Selenium	7740	5100	mg/kg
Silver	6010	5100	mg/kg
Sodium	6010	-	-
Thallium	7841	-	-
Vanadium	6010	7200	mg/kg
Zinc	6010	310000	mg/kg
CONVENTIONALS			
Boron	6010	92000	mg/kg
Calcium	6010	-	-
Iron	6010	-	-
Cyanide, Total	9010	20000	mg/kg
Magnesium	6010	-	-
Manganese	6010	-	-
Mercury	7470	310	mg/kg
Sulfide	9030	-	-
Total Petroleum Hydrocarbons	8015M	-	-
RCRA SUBTITLE D APPENDIX I VOLATILE ORGANIC COMPOUNDS			
Acetone	8260	100000	mg/kg
Acrylonitrile	8260	530	mg/kg
Benzene	8260	9900	mg/kg
Bromochloromethane	8260	-	-
Bromodichloromethane	8260	4600	mg/kg
Bromoform (Tribromomethane)	8260	36000	mg/kg
Bromomethane (Methyl bromide)	8260	1400	mg/kg
Carbon disulfide	8260	100000	mg/kg
Carbon tetrachloride	8260	2200	mg/kg
Chlorobenzene	8260	20000	mg/kg
Chloroethane	8260	410000	mg/kg
Chloroform (Trichloromethane)	8260	47000	mg/kg
Chloromethane (Methyl chloride)	8260	22000	mg/kg
1,2-Dibromo-3-chloropropane	8260	200	mg/kg
Dibromochloromethane	8260	3400	mg/kg
1,2-Dibromoethane (Ethylene dibromide)	8260	3.4	mg/kg
trans-1,4-Dichloro-2-butene	8260	-	-
1,2-Dichlorobenzene (o-DCB)	8260	92000	mg/kg
1,4-Dichlorobenzene (p-DCB)	8260	12000	mg/kg
1,1-Dichloroethane	8260	100000	mg/kg
1,2-Dichloroethane	8260	3100	mg/kg
1,1-Dichloroethene	8260	480	mg/kg
cis-1,2-Dichloroethene	8260	10000	mg/kg
trans-1,2-Dichloroethene	8260	20000	mg/kg
1,2-Dichloropropane	8260	4200	mg/kg
cis-1,3-Dichloropropene	8260	-	-
trans-1,3-Dichloropropene	8260	-	-
Ethylbenzene	8260	100000	mg/kg
2-Hexanone	8260	-	-
Methyl ethyl ketone (2-Butanone)	8260	610000	mg/kg
Methyl iodide (Iodomethane)	8260	-	-
Methyl isobutyl ketone (4-Methyl-2-pentanone)	8260	82000	mg/kg
Methylene bromide (Dibromomethane)	8260	10000	mg/kg

Footnotes provided on page 3

TABLE 2-4

SEDIMENT SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA LIMITS[2]	
		Limit	Units
Methylene chloride (Dichloromethane)	8260	38000	mg/kg
Styrene	8260	200000	mg/kg
1,1,1,2-Tetrachloroethane	8260	11000	mg/kg
1,1,2,2-Tetrachloroethane	8260	1400	mg/kg
Tetrachloroethene	8260	5500	mg/kg
Toluene	8260	200000	mg/kg
1,1,1-Trichloroethane	8260	92000	mg/kg
1,1,2-Trichloroethane	8260	5000	mg/kg
Trichloroethene	8260	26000	mg/kg
Trichlorofluoromethane (Freon 11)	8260	310000	mg/kg
1,2,3-Trichloropropane	8260	41	mg/kg
Vinyl acetate	8260	100000	mg/kg
Vinyl chloride	8260	150	mg/kg
Xylenes	8260	100000	mg/kg
TCL SEMIVOLATILE ORGANIC COMPOUNDS			
Acenaphthene	8270	61000	mg/kg
Acenaphthylene	8270	-	-
Anthracene	8270	310000	mg/kg
Benzo(a)anthracene	8270	390	mg/kg
Benzo(a)pyrene	8270	39	mg/kg
Benzo(b)fluoranthene	8270	390	mg/kg
Benzo(ghi)perylene	8270	-	-
Benzo(k)fluoranthene	8270	3900	mg/kg
4-Bromophenyl phenyl ether	8270	59000	mg/kg
Butyl benzyl phthalate	8270	200000	mg/kg
Carbazole	8270	-	-
p-Chloro-m-cresol (4-Chloro-3-methylphenol)	8270	-	-
4-Chloroaniline	8270	4100	mg/kg
bis(2-Chloroethoxy)methane	8270	-	-
bis(2-Chloroethyl)ether	8270	260	mg/kg
bis(2-Chloroisopropyl)ether [bis(2-Chloro-1-methyleth	8270	4100	mg/kg
2-Chloronaphthalene	8270	82000	mg/kg
2-Chlorophenol	8270	5100	mg/kg
4-Chlorophenyl phenyl ether	8270	-	-
Chrysene	8270	39000	mg/kg
m-Cresol (3-Methylphenol)	8270	51000	mg/kg
o-Cresol (2-Methylphenol)	8270	51000	mg/kg
p-Cresol (4-Methylphenol)	8270	5100	mg/kg
Dibenzo(a,h)anthracene	8270	39	mg/kg
Dibenzofuran	8270	-	-
1,3-Dichlorobenzene (m-DCB)	8270	91000	mg/kg
3,3'-Dichlorobenzidine	8270	640	mg/kg
2,4-Dichlorophenol	8270	3100	mg/kg
Diethyl phthalate	8270	820000	mg/kg
Dimethyl phthalate	8270	1000000	mg/kg
2,4-Dimethylphenol	8270	20000	mg/kg
Di-n-butyl phthalate	8270	100000	mg/kg
4,6-Dinitro-o-cresol	8270	-	-
2,4-Dinitrophenol	8270	2000	mg/kg
2,4-Dinitrotoluene	8270	2000	mg/kg
2,6-Dinitrotoluene	8270	1000	mg/kg
Di-n-octyl phthalate	8270	20000	mg/kg
bis(2-Ethylhexyl) phthalate	8270	20000	mg/kg
Fluoranthene	8270	41000	mg/kg
Fluorene	8270	41000	mg/kg
Hexachlorobenzene	8270	180	mg/kg
Hexachlorobutadiene	8270	3700	mg/kg
Hexachlorocyclopentadiene	8270	7200	mg/kg
Hexachloroethane	8270	20000	mg/kg
Indeno(1,2,3-cd)pyrene	8270	390	mg/kg
Isophorone	8270	300000	mg/kg
2-Methylnaphthalene	8270	-	-

Footnotes provided on page 3

TABLE 2-4

SEDIMENT SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA LIMITS[2]	
		Limit	Units
Naphthalene	8270	41000	mg/kg
2-Nitroaniline	8270	61	mg/kg
3-Nitroaniline	8270	3100	mg/kg
4-Nitroaniline	8270	3100	mg/kg
Nitrobenzene	8270	510	mg/kg
2-Nitrophenol	8270	-	-
4-Nitrophenol	8270	63000	mg/kg
N-Nitrosodi-n-propylamine	8270	41	mg/kg
N-Nitrosodiphenylamine	8270	58000	mg/kg
Pentachlorophenol	8270	2400	mg/kg
Phenanthrene	8270	-	-
Phenol	8270	610000	mg/kg
Pyrene	8270	31000	mg/kg
1,2,4-Trichlorobenzene	8270	10000	mg/kg
2,4,5-Trichlorophenol	8270	100000	mg/kg
2,4,6-Trichlorophenol	8270	26000	mg/kg
TCL PESTICIDES & PCBs			
Aldrin	8080	17	mg/kg
alpha-BHC	8080	45	mg/kg
beta-BHC	8080	160	mg/kg
delta-BHC	8080	-	-
gamma-BHC (Lindane)	8080	220	mg/kg
alpha-Chlordane	8080	220	mg/kg
gamma-Chlordane	8080	220	mg/kg
4,4'-DDD	8080	1200	mg/kg
4,4'-DDE	8080	840	mg/kg
4,4'-DDT	8080	840	mg/kg
Dieldrin	8080	18	mg/kg
Endosulfan I	8080	-	-
Endosulfan II	8080	-	-
Endosulfan sulfate	8080	-	-
Endrin	8080	310	mg/kg
Endrin aldehyde	8080	-	-
Endrin ketone	8080	-	-
Heptachlor	8080	64	mg/kg
Heptachlor epoxide	8080	31	mg/kg
Methoxychlor	8080	5100	mg/kg
Toxaphene	8080	260	mg/kg
Aroclor-1016	8080	37	mg/kg
Aroclor-1221	8080	37	mg/kg
Aroclor-1232	8080	37	mg/kg
Aroclor-1242	8080	37	mg/kg
Aroclor-1248	8080	37	mg/kg
Aroclor-1254	8080	37	mg/kg
Aroclor-1260	8080	37	mg/kg

NOTES:

1. Analytical methods may be determined by actual concentrations detected and the health-based criteria.
2. Actual quantitation limits provided by the laboratory will be equal to or less than the health-based criteria. The actual quantitation limits will be provided by the laboratory in the addendum to the QAPP.

- : Not applicable

mg/kg: milligrams per kilogram

TCL: Target Compound List

PCBs: Polychlorinated Biphenyls

TABLE 2-5

SOIL SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA[2] Limit	Units
RCRA SUBTITLE D APPENDIX I METALS			
Antimony	7041	410	mg/kg
Arsenic	7060	160	mg/kg
Barium	6010	72000	mg/kg
Beryllium	6010	67	mg/kg
Cadmium	6010	510	mg/kg
Chromium	6010	5100	mg/kg
Cobalt	6010	180000	mg/kg
Copper	6010	38000	mg/kg
Iron	6010	-	-
Lead	7421	-	-
Nickel	6010	20000	mg/kg
Selenium	7740	5100	mg/kg
Silver	6010	5100	mg/kg
Sodium	6010	-	-
Thallium	7841	-	-
Vanadium	6010	7200	mg/kg
Zinc	6010	310000	mg/kg
CONVENTIONALS			
Boron	6010	92000	mg/kg
Calcium	6010	-	-
Magnesium	6010	-	-
Cyanide, Total	9010	20000	mg/kg
Manganese	6010	-	-
Mercury	7470	310	mg/kg
Sulfide	9030	-	-
Total Petroleum Hydrocarbons	8015M	-	-
Total Organic Carbon (TOC)	-	-	-
RCRA APPENDIX I VOLATILE ORGANIC COMPOUNDS			
Acetone	8260	100000	mg/kg
Acrylonitrile	8260	530	mg/kg
Benzene	8260	9900	mg/kg
Bromochloromethane	8260	-	-
Bromodichloromethane	8260	4600	mg/kg
Bromoform	8260	36000	mg/kg
Bromomethane	8260	1400	mg/kg
Carbon disulfide	8260	100000	mg/kg
Carbon tetrachloride	8260	2200	mg/kg
Chlorobenzene	8260	20000	mg/kg
Chloroethane	8260	410000	mg/kg
Chloroform	8260	47000	mg/kg
Chloromethane	8260	22000	mg/kg
1,2-Dibromo-3-chloropropane	8260	200	mg/kg
Dibromochloromethane	8260	3400	mg/kg
1,2-Dibromoethane	8260	3.4	mg/kg
trans-1,4-Dichloro-2-butene	8260	-	-
1,2-Dichlorobenzene (o-DCB)	8260	92000	mg/kg
1,4-Dichlorobenzene (p-DCB)	8260	12000	mg/kg
1,1-Dichloroethane	8260	100000	mg/kg
1,2-Dichloroethane	8260	3100	mg/kg
1,1-Dichloroethene	8260	480	mg/kg
cis-1,2-Dichloroethene	8260	10000	mg/kg
trans-1,2-Dichloroethene	8260	20000	mg/kg
1,2-Dichloropropane	8260	4200	mg/kg
cis-1,3-Dichloropropene	8260	-	-
trans-1,3-Dichloropropene	8260	-	-
Ethylbenzene	8260	100000	mg/kg
2-Hexanone	8260	-	-
Methyl ethyl ketone	8260	610000	mg/kg
Methyl iodide	8260	-	-
Methyl isobutyl ketone	8260	82000	mg/kg
Methylene bromide	8260	10000	mg/kg

Footnotes provided on page 3

TABLE 2-5
SOIL SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA[2] Limit	Units
Methylene chloride (Dichloromethane)	8260	38000	mg/kg
Styrene	8260	200000	mg/kg
1,1,1,2-Tetrachloroethane	8260	11000	mg/kg
1,1,2,2-Tetrachloroethane	8260	1400	mg/kg
Tetrachloroethene	8260	5500	mg/kg
Toluene	8260	200000	mg/kg
1,1,1-Trichloroethane	8260	92000	mg/kg
1,1,2-Trichloroethane	8260	5000	mg/kg
Trichloroethene	8260	26000	mg/kg
Trichlorofluoromethane (Freon 11)	8260	310000	mg/kg
1,2,3-Trichloropropane	8260	41	mg/kg
Vinyl acetate	8260	100000	mg/kg
Vinyl chloride	8260	150	mg/kg
Xylenes	8260	100000	mg/kg
TCL SEMIVOLATILE ORGANIC COMPOUNDS			
Acenaphthene	8270	61000	mg/kg
Acenaphthylene	8270	-	-
Anthracene	8270	310000	mg/kg
Benzo(a)anthracene	8270	390	mg/kg
Benzo(a)pyrene	8270	39	mg/kg
Benzo(b)fluoranthene	8270	390	mg/kg
Benzo(ghi)perylene	8270	-	-
Benzo(k)fluoranthene	8270	3900	mg/kg
4-Bromophenyl phenyl ether	8270	59000	mg/kg
Butyl benzyl phthalate	8270	200000	mg/kg
Carbazole	8270	-	-
p-Chloro-m-cresol	8270	-	-
4-Chloroaniline	8270	4100	mg/kg
bis(2-Chloroethoxy)methane	8270	-	-
bis(2-Chloroethyl)ether	8270	260	mg/kg
bis(2-Chloroisopropyl)ether [bis(2-Chloro-1	8270	4100	mg/kg
2-Chloronaphthalene	8270	82000	mg/kg
2-Chlorophenol	8270	5100	mg/kg
4-Chlorophenyl phenyl ether	8270	-	-
Chrysene	8270	39000	mg/kg
m-Cresol	8270	51000	mg/kg
o-Cresol	8270	51000	mg/kg
p-Cresol	8270	5100	mg/kg
Dibenzo(a,h)anthracene	8270	39	mg/kg
Dibenzofuran	8270	-	-
1,3-Dichlorobenzene	8270	91000	mg/kg
3,3'-Dichlorobenzidine	8270	640	mg/kg
2,4-Dichlorophenol	8270	3100	mg/kg
Diethyl phthalate	8270	820000	mg/kg
Dimethyl phthalate	8270	1000000	mg/kg
2,4-Dimethylphenol	8270	20000	mg/kg
Di-n-butyl phthalate	8270	100000	mg/kg
4,6-Dinitro-o-cresol	8270	-	-
2,4-Dinitrophenol	8270	2000	mg/kg
2,4-Dinitrotoluene	8270	2000	mg/kg
2,6-Dinitrotoluene	8270	1000	mg/kg
Di-n-octyl phthalate	8270	20000	mg/kg
bis(2-Ethylhexyl) phthalate	8270	20000	mg/kg
Fluoranthene	8270	41000	mg/kg
Fluorene	8270	41000	mg/kg
Hexachlorobenzene	8270	180	mg/kg
Hexachlorobutadiene	8270	3700	mg/kg
Hexachlorocyclopentadiene	8270	7200	mg/kg
Hexachloroethane	8270	20000	mg/kg
Indeno(1,2,3-cd)pyrene	8270	390	mg/kg
Isophorone	8270	300000	mg/kg
2-Methylnaphthalene	8270	-	-
Naphthalene	8270	41000	mg/kg

Footnotes provided on page 3

TABLE 2-5

SOIL SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD[1]	HEALTH-BASED CRITERIA[2]	
		Limit	Units
2-Nitroaniline	8270	61	mg/kg
3-Nitroaniline	8270	3100	mg/kg
4-Nitroaniline	8270	3100	mg/kg
Nitrobenzene	8270	510	mg/kg
2-Nitrophenol	8270	-	-
4-Nitrophenol	8270	63000	mg/kg
N-Nitrosodi-n-propylamine	8270	41	mg/kg
N-Nitrosodiphenylamine	8270	58000	mg/kg
Pentachlorophenol	8270	2400	mg/kg
Phenanthrene	8270	-	-
Phenol	8270	610000	mg/kg
Pyrene	8270	31000	mg/kg
1,2,4-Trichlorobenzene	8270	10000	mg/kg
2,4,5-Trichlorophenol	8270	100000	mg/kg
2,4,6-Trichlorophenol	8270	26000	mg/kg
TCL PESTICIDES & PCBs			
Aldrin	8080	17	mg/kg
alpha-BHC	8080	45	mg/kg
beta-BHC	8080	160	mg/kg
delta-BHC	8080	-	-
gamma-BHC (Lindane)	8080	220	mg/kg
alpha-Chlordane	8080	220	mg/kg
gamma-Chlordane	8080	220	mg/kg
4,4'-DDD	8080	1200	mg/kg
4,4'-DDE	8080	840	mg/kg
4,4'-DDT	8080	840	mg/kg
Dieldrin	8080	18	mg/kg
Endosulfan I	8080	-	-
Endosulfan II	8080	-	-
Endosulfan sulfate	8080	-	-
Endrin	8080	310	mg/kg
Endrin aldehyde	8080	-	-
Endrin ketone	8080	-	-
Heptachlor	8080	64	mg/kg
Heptachlor epoxide	8080	31	mg/kg
Methoxychlor	8080	5100	mg/kg
Toxaphene	8080	260	mg/kg
Aroclor-1016	8080	37	mg/kg
Aroclor-1221	8080	37	mg/kg
Aroclor-1232	8080	37	mg/kg
Aroclor-1242	8080	37	mg/kg
Aroclor-1248	8080	37	mg/kg
Aroclor-1254	8080	37	mg/kg
Aroclor-1260	8080	37	mg/kg

NOTES:

1. Analytical methods may be determined by the total concentrations detected and the health-based criteria.
2. Actual quantitation limits provided by the laboratory will be equal to or less than the health-based criteria limits. The actual quantitation limits will be provided by the laboratory in the addendum to the QAPP.

- : Not applicable

mg/kg: milligrams per kilogram

TCL: Target Compound List

PCBs: Polychlorinated Biphenyls

TABLE 2-6
GAS SAMPLE PARAMETER LIST

PARAMETER	ANALYTICAL METHOD	HEALTH-BASED CRITERIA[2]	
		Limit	Units
VOLATILE ORGANIC COMPOUNDS			
Acetone	TO-14	370	ug/m^3
Benzene	TO-14	22	ug/m^3
Benzyl Chloride	TO-14	3.7	ug/m^3
Bromodichloromethane	TO-14	10	ug/m^3
Bromoform	TO-14	160	ug/m^3
Bromomethane	TO-14	5.2	ug/m^3
Carbon disulfide	TO-14	10	ug/m^3
Carbon tetrachloride	TO-14	12	ug/m^3
Chlorobenzene	TO-14	21	ug/m^3
Chloroethane	TO-14	10000	ug/m^3
Chloroform	TO-14	7.8	ug/m^3
Chloromethane	TO-14	99	ug/m^3
Dibromochloromethane	TO-14	7.5	ug/m^3
1,2-Dibromoethane	TO-14	0.81	ug/m^3
1,2-Dichlorobenzene	TO-14	210	ug/m^3
1,3-Dichlorobenzene	TO-14	320	ug/m^3
1,4-Dichlorobenzene	TO-14	26	ug/m^3
Dichlorodifluoromethane (Freon 12)	TO-14	210	ug/m^3
1,1-Dichloroethane	TO-14	520	ug/m^3
1,2-Dichloroethane	TO-14	6.9	ug/m^3
1,1-Dichloroethene	TO-14	3.6	ug/m^3
cis-1,2-Dichloroethene	TO-14	37	ug/m^3
trans-1,2-Dichloroethene	TO-14	73	ug/m^3
1,2-Dichloropropane	TO-14	9.2	ug/m^3
cis-1,3-Dichloropropene	TO-14	4.8	ug/m^3
trans-1,3-Dichloropropene	TO-14	4.8	ug/m^3
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	TO-14	-	-
Ethylbenzene	TO-14	1000	ug/m^3
4-Ethyltoluene	TO-14	-	-
Hexachlorobutadiene	TO-14	8.1	ug/m^3
2-Hexanone	TO-14	-	-
Methyl ethyl ketone	TO-14	1000	ug/m^3
Methyl isobutyl ketone	TO-14	84	ug/m^3
Methylene chloride	TO-14	380	ug/m^3
Styrene	TO-14	1000	ug/m^3
1,1,2,2-Tetrachloroethane	TO-14	3.1	ug/m^3
Tetrachloroethene	TO-14	310	ug/m^3
Toluene	TO-14	420	ug/m^3
1,2,4-Trichlorobenzene	TO-14	210	ug/m^3
1,1,1-Trichloroethane	TO-14	1000	ug/m^3
1,1,2-Trichloroethane	TO-14	11	ug/m^3
Trichloroethene	TO-14	100	ug/m^3
Trichlorofluoromethane (Freon 11)	TO-14	730	ug/m^3
1,1,2-Tirchloro-1,2,2-Trifluoroethane (Freon 113)	TO-14	31000	ug/m^3
1,3,5-Trimethylbenzene	TO-14	1.5	ug/m^3
1,2,4-Trimethylbenzene	TO-14	1.8	ug/m^3
Vinyl acetate	TO-14	210	ug/m^3
Vinyl chloride	TO-14	2.1	ug/m^3
p-Xylene	TO-14	310	ug/m^3
m- or o-Xylene	TO-14	730	ug/m^3

NOTES:

1. Analytical methods may be determined by the actual concentration detected and the health-based criteria.
2. Actual quantitation limits provided by the laboratory will be equal to or less than the health-based criteria. The actual quantitation limits will be provided by the laboratory in the addendum to the QAPP.

- : Not applicable
ug/cm3: micrograms per cubic centimeter

LEGEND

PERIMETER BERM

REV.	DATE	DESCRIPTION	DR. BY	APP. BY

CLIENT/PROJECT: LAIDLAW — LAIDLAW WASTE SYSTEMS INC.

WEST LAKE LANDFILL
OPERABLE UNIT 2

TITLE: SITE FEATURES MAP

Golder Associates — Denver, Colorado

DRAWN	TMC	DATE	APRIL 1995
CHECKED	CER	SCALE	AS SHOWN
REVIEWED	WEH	JOB NO.	943-2848
APPROVED		DWG. NO.	D030
FILE NO.	2848D030	FIGURE	2-1

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Responsibilities for overall project quality are shared by all parties associated with the OU-2 RI/FS. The project organization is shown on Figure 3-1. Project organization and management is discussed in detail in Section 7 of the Work Plan.

Laidlaw, as sole respondent to the OU-2 AOC, will respond directly to the EPA for implementation of the OU-2 RI/FS. Laidlaw has entered into a contract with Golder for the performance of this RI/FS.

The chemical analytical laboratory will be contracted directly by Laidlaw and will be responsible for ensuring that the performance of the laboratory analyses is consistent with the requirements of the project as defined by the Work Plan and this QAPP. Laidlaw has solicited bids for the analytical testing portion of the OU-2 RI/FS but has not yet selected a laboratory. Upon selection of an analytical laboratory, an addendum to the QAPP, containing the information specified in this QAPP, will be submitted to the EPA for approval. Additional subcontractors will be selected for various tasks as needed.

3.1 Overall Responsibility

3.1.1 EPA Remedial Project Manager

Mr. Steve Kinser will be responsible for conducting and/or coordinating EPA review of the QAPP, work plans and all project deliverables. In addition, Mr. Kinser will supply comments on technical issues of sampling, laboratory analyses, and data interpretation. Mr. Kinser can be reached at the following address:

Remedial Project Manager
EPA Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101
Phone: (913) 551-7728

3.1.2 Laidlaw Project Manager

Mr. Doug Borro will be responsible for technical negotiations with the EPA on behalf of Laidlaw Waste Systems. Mr. Borro will lead any negotiations and meetings with the regulatory agencies. He will review major technical evaluations and reports and will also be responsible for ensuring that appropriate resources are made available to the project in a timely manner. Mr. Borro can be reached at the following address:

Laidlaw Waste Systems Ltd.
3221 North Service Road
Burlington, Ontario
Canada L7R 3Y8
Phone: (905) 336-5151

3.1.3 Golder Project Manager

Mr. Ward Herst, Golder Project Manager, will participate in technical negotiations with the EPA on behalf of Laidlaw Waste Systems. Mr. Herst will provide general oversight, coordination and guidance for the project. He will review major technical evaluations and reports and will also be responsible for ensuring that appropriate resources are made available to the project in a timely manner. He will be responsible for implementing the project plans, scheduling, cost control and integration of the various technical disciplines that will be required during this project. Mr. Herst can be reached at the following address:

12777 Castlebar Drive
St. Louis, Missouri 63146
Phone: (314) 770-0194

3.1.4 Golder QA Officer

Dr. Jay Corgiat will be the Golder QA officer for the West Lake Landfill OU-2 RI. The QA Officer retains the necessary organizational independence and authority to identify conditions adverse to quality and to inform the Project Manager of needed corrective action. Dr. Corgiat will be responsible for review and approval of Quality Assurance Project Plans, subsequent reports and SOPs, and ensuring that appropriate aspects of the program are correctly performed. He or his designee will be responsible for conducting audits of field activities to verify that procedures conform to stated objectives. He or his designee will also be responsible for identifying and controlling non-conformance and implementing corrective actions. Dr. Corgiat or his designee will be responsible for verifying analytical laboratory compliance including monitoring laboratory bottle quality with the approved project-specific analytical methods. He or his designee will be responsible for performing data validation method and compliance verification, assessment of data sufficiency and reviewing tentatively identified compounds and assessing their relevance to the project. Dr. Corgiat can be reached at the following address:

Golder Associates Inc.
1809 North Mill Street, Suite C
Naperville, Illinois 60563
Phone: (708) 357-206

3.1.5 Golder Field Team Leader

Mr. Brian Tilton, the Golder Field Team Leader, will support the Project Manager and is responsible for leading and coordinating the day-to-day activities of the various resource specialists under supervision. The Golder Field Team Leader will report directly to the Project Manager. Specific responsibilities include:

- Development and implementation of field related work plans, assurance of schedule compliance and adherence to management-developed study requirements;
- Coordination and management of field staff;
- Implementation of QC for technical data provided by the field staff including field measurement data;
- Adherence to established project schedule;
- Review and approval of text and graphics required for field team efforts; and,
- Identification of problems at the field team level and provision of communication between team and upper management.

3.1.6 Golder Technical Staff

The technical team staff will be utilized to gather and analyze data, and prepare various task reports and support materials.

3.2 Specialized Responsibilities

3.2.1 Monitoring and Sampling Operations and QC

- Drilling:

  - 100 and 200 series piezometers:

    Dave Meyers
    Layne Western, Inc.
    2399 Cassens Drive
    Fenton, Missouri 63026

  - 300 series piezometers: To Be Determined

- Surveying:

  Jim Sherbut
  Sherbut-Carson & Associates P.C.
  4 Meadow Heights
  Professional Park
  Collinsville, Illinois 62234

- Geophysics:

  Kenneth Wooddell Jr.
  Wooddell Logging Inc.
  P.O. Box 1095
  Mattoon, Illinois 61938

- Sampling and Monitoring:

  Golder Staff

- On-Site Day-to-Day Field Activities:

  Golder Staff

- Quality Control

  Dr. Jay Corgiat, Golder QA Officer

3.2.2 Laboratory Analysis

To be determined through bidding process.

3.2.3 Laboratory Data and QA

- Review and approval of analytical procedures

  Mr. Steve Kinser or designee, EPA Region VII

- Internal QA/QC

  Laboratory Project QA Officer

- Final data review

  Dr. Jay Corgiat, Golder QA Officer

3.2.4 Performance and Systems Audits

3.2.4.1 Field Operations

- Internal Audits

  Dr. Jay Corgiat, Golder QA Officer or designee

- External Audits

  Mr. Steve Kinser, EPA Region VII or designee

3.2.4.2 Analytical Laboratories

- Internal Audits

  Laboratory Project QA Officer

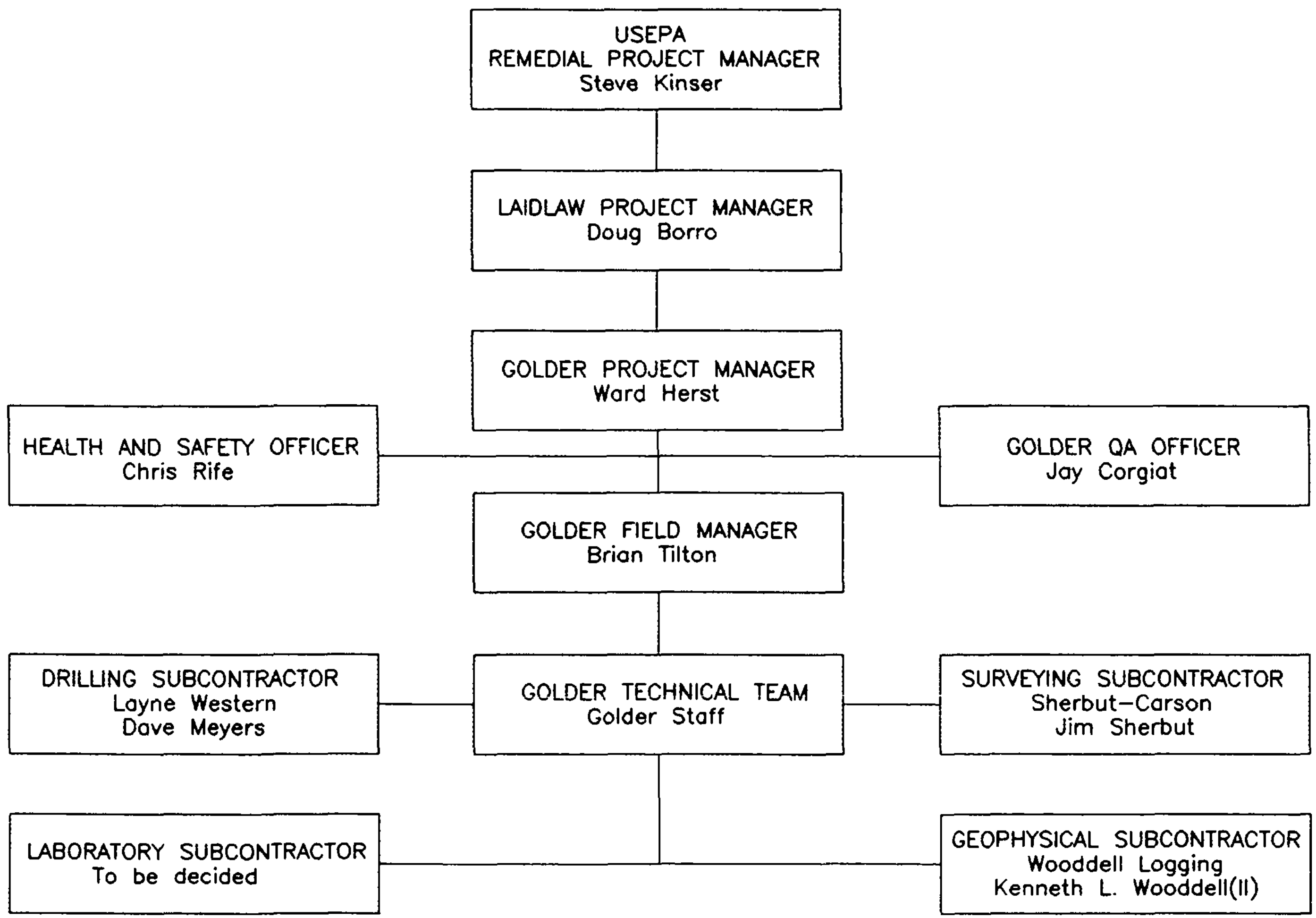
- External Audits

  Mr. Steve Kinser, EPA Region VII or designee

3.2.4.3 Final Evidence File

- Final Evidence File Audits

  Mr. Ward Herst, Golder Project Manager or designee



CLIENT/PROJECT: LAIDLAW WASTE SYSTEMS INC. WEST LAKE LANDFILL OPERABLE UNIT 2			Golder Associates DENVER, COLORADO			TITLE: ORGANIZATIONAL CHART FOR THE WEST LAKE LANDFILL OU-2 RI/FS		
DRAWN SMA	CHECKED CER	REVIEWED WEH	DATE APRIL 1995	SCALE NO SCALE	FILE NO. 2848A062	JOB NO. 943-2848	DWG NO./REV.NO. A062	FIGURE 3-1

4.0 QUALITY ASSURANCE OBJECTIVES

Data needs and quality objectives for the West Lake Landfill OU-2 RI are summarized in Table 4-1. Analytical data obtained from environmental media sampling activities will be evaluated to characterize the nature, extent, and sources of contamination (if identified), to evaluate contaminant fate and transport, and to determine the most feasible options for remediation (including no-action). Analytical data will also be utilized by the EPA to complete the baseline risk assessment. This section describes the quality assurance objectives for analyses of the contaminants of concern by describing the analytical data levels; level of quality control effort; the accuracy, precision and sensitivity of analysis; and completeness, representativeness, and comparability requirements.

4.1 Level of Quality Control Effort

Equipment rinsate samples, trip blank, duplicate, split and matrix spike samples will be submitted to the analytical laboratory and analyzed to assess the quality of the data resulting from the field sampling program.

Equipment rinsate samples will be analyzed to check for procedural contamination at the site. Equipment rinsate samples of landfill gas will consist of ambient (background) air. Equipment rinsate samples will not be taken when dedicated, new or disposable pre-cleaned equipment is used for sampling. The general level of the QC effort will be one equipment rinsate sample for every ten or fewer aqueous or gas investigative samples collected.

Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage. Trip blank samples for aqueous matrices will consist of deionized water. Trip blanks associated with landfill gas samples will consist of evacuated SUMMA™ canisters. Trip blanks will not be included with soil/sediment samples. These blanks will be shipped from the laboratory to the site and returned to the laboratory with the samples. One volatile organic analysis (VOA) trip blank consisting of laboratory-prepared deionized ultra pure water will be included with each cooler containing aqueous VOA samples. One evacuated SUMMA™ canister will be included with each cooler containing gas samples

Field duplicate samples will be analyzed to check for sampling and analytical reproducability. Field duplicates will be analyzed for aqueous matrices only. The general level of the QC effort will be one field duplicate for every ten or fewer investigative samples.

Matrix spikes provide information about the effect of the sample matrix on the digestion and measurement methodology. Matrix spikes are performed in duplicate for VOCs and are hereinafter referred to as matrix spikes/matrix spikes-duplicate (MS/MSD) samples. MS/MSD samples are not investigative samples; they are QC analyses performed on separate aliquots of investigative samples.

Sampling procedures are specified in the Field Sampling Plan (Appendix A-1 of the Work Plan). An estimated number of investigative and QA/QC samples from RI activities is shown in Table 2-1.

The level of laboratory QC effort for the testing of the parameters will conform to the Standard Operating Procedures (SOPs) for each respective constituent. These SOPs will be provided or referenced in the addendum to the QAPP.

4.2 Accuracy, Precision, and Sensitivity of Analysis

The fundamental QA objective with respect to accuracy, precision and sensitivity of laboratory analytical data is to achieve the QC acceptance criteria of the analytical protocols. SOPs for laboratory analyses will be provided by the chemical analytical laboratory, and will be submitted or referenced in the addendum to the QAPP. These will include the required accuracy, precision and sensitivity of the analyses. SOPs for the field equipment to measure soil head space, pH, temperature, turbidity, and specific conductivity are outlined in the manufacturer's operation manual.

4.3 Completeness, Representativeness, and Comparability

Completeness is a measure of the amount of valid data obtained from a measurement round compared to the amount that was expected to be obtained under normal conditions. The percent completeness may be calculated by the following equation:

$$completeness(\%) = \frac{number\ of\ valid\ data}{number\ of\ samples\ collected\ for\ each\ parameter\ analyzed} * 100$$

The completeness goals for this project are as follows:

- 95% for groundwater;
- 80% for surface water samples;
- 80% for sediment samples;
- 95% for subsurface soil samples;
- 95% for landfill gas samples;

- 75% for soil gas samples; and,
- 90% for field measurements (the completeness will probably be 100 percent because analyses can generally be repeated).

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition or an environmental condition. Representativeness is a qualitative parameter which is dependent upon the proper design of the sampling program and proper laboratory protocol. Representativeness will be satisfied by insuring that the SAP is followed, proper sampling techniques are used, proper analytical procedures are followed, and holding times of the samples are not exceeded in the laboratory. Representativeness will be assessed by the analysis of field duplicate/split samples.

Comparability expresses the confidence with which one data set can be compared with another. The extent to which existing and future analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to obtain the different rounds of analytical data are expected to provide comparable data. These new analytical data, however, may not be directly comparable to existing data because of differences in procedures and QA objectives. The results obtained for each set of samples collected during this investigation will be compared with data from preceding sampling rounds and previous investigations to identify analytical results that may appear anomalous and may require checking.

TABLE 4-1

REMEDIAL INVESTIGATION TASK
DATA QUALITY NEEDS AND OBJECTIVES

Task/Subtask	Data Application	Analytical Level	QA/QC Samples	Objectives	Chemicals of Concern	Required Detection Levels
SITE PHYSICAL AND BIOLOGICAL CHARACTERIZATION						
Surficial Geologic Investigation	Site Characterization	NA	NA	Identify site features to define potential transport pathways and human and ecological receptor populations.	NA	NA
Ecological Evaluation	Site Characterization Risk Assessment	NA	NA	Provide an understanding of the site and vicinity ecological setting, including flora and fauna, critical habitats, and endangered species.	NA	NA
Physical Characteristics and Demographics	Site Characterization Risk Assessment	NA	NA	Provide an understanding of land use and population in the vicinity of the site.	NA	NA
SITE HYDROGEOLOGICAL CHARACTERIZATION						
Well Integrity Evaluation	Site Characterization Risk Assessment	NA	NA	Identify existing wells which may be suitable for hydrogeologic characterization and/or water quality testing.	NA	NA
Hydrogeologic Investigation						
▸ Aquifer Testing	Site Characterization Remedial Design	Level II	None	Determine aquifer characteristics such as vertical and horizontal flow gradients, flow rates, aquifer thickness, and permeability.	NA	Instrument Sensitivity

Footnotes are provided on page 3.

TABLE 4-1

REMEDIAL INVESTIGATION TASK
DATA QUALITY NEEDS AND OBJECTIVES

Task/Subtask	Data Application	Analytical Level	QA/QC Samples	Objectives	Chemicals of Concern	Required Detection Levels
SITE HYDROGEOLOGICAL CHARACTERIZATION continued						
▸ Subsurface Soil Sampling and Analysis	Site Characterization Remedial Design	Level III	Field Duplicate Rinsate Blank Trip Blank	Assist in determining chemical compound transport in groundwater.	TOC	Method Detection Limits
▸ Geotechnical Sampling and Analysis	Site Characterization Remedial Design	Level II	NA	Determine structural integrity of landfill cover.	NA	Instrument Sensitivity
▸ Groundwater Sampling and Analysis	Site Characterization Remedial Design Risk Assessment	Level III	Background Field Duplicate Rinsate Blank Trip Blank	Identify nature and extent of groundwater impacts. Determine need for groundwater remediation.	VOCs, SVOCs, pesticides, PCBs metals, cyanide, and TPH.*	Risk-based detection limits
SOURCE CHARACTERIZATION						
Leachate Sampling and Analysis	Source Characterization Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank	Characterize leachate.	VOCs, SVOCs, pesticides, PCBs metals, cyanide, and TPH.*	Method detection limits
Landfill Gas Sampling and Analysis	Source Characterization Remedial Design Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank	Characterize Landfill Gas.	VOCs*, methane	Risk-based detection limits
Hydrocarbon Investigation Near MW-F2						
▸ Subsurface Soil, Leachate, and Groundwater Sampling and Analysis	Source Characterization Remedial Design Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank	Characterize extent of hydrocarbon impacts near MW-F2.	BTEX, TPH	Method detection limits

Footnotes are provided on page 3.

TABLE 4-1

REMEDIAL INVESTIGATION TASK
DATA QUALITY NEEDS AND OBJECTIVES

Task/Subtask	Data Application	Analytical Level	QA/QC Samples	Objectives	Chemicals of Concern	Required Detection Levels
SITE HYDROLOGIC CHARACTERIZATION						
▸ Surface Water Sampling and Analysis	Site Characterization Remedial Design Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank	Characterize surface water, determine need for remediation.	VOCs, SVOCs, pesticides, PCBs metals, cyanide, and TPH.*	Method detection limits
▸ Seep Survey, Sampling, and Analysis	Site Characterization Risk Assessment	Level III	Field Duplicate Rinsate Blank Trip Blank	Characterize seeps.	VOCs, SVOCs, pesticides, PCBs metals, cyanide, and TPH.*	Method detection limits
SITE AIR QUALITY CHARACTERIZATION						
Air Quality Monitoring	Site Characterization Remedial Design Risk Assessment Health and Safety	Level I	None	Determine impacts to ambient air quality from landfill gas, monitor for health and safety purposes.	VOCs, O_2, methane	Instrument Sensitivity

* For specific analytes, see Tables 2-2 through 2-6.
NA = Not applicable
TOC = Total Organic Carbon
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PCB = Polychlorinated biphenyl
TPH = Total petroleum hydrocarbon
BTEX = Benzene, toluene, ethylbenzene, xylene
AOC = Administrative Order on Consent (EPA, 1994b)

5.0 SAMPLING PROCEDURES

Sampling procedures are described in the Field Sampling Plan (Appendix A-1).

5.1 Bottle Requirements

The contaminant-free sample containers (bottles) used for analyzing organics and inorganics for the West Lake Landfill OU-2 site will be prepared according to the procedures specified in the EPA's *Specifications and Guidance for Obtaining Contaminant-Free Sample Containers*. Required sample quantities, containers, preservatives and packaging are presented in Table 5-1.

In addition, the data for equipment blanks and trip blanks will be monitored for contamination, and corrective actions will be taken as soon as a problem is identified. This may be accomplished by discontinuing the use of a specific bottle lot, contacting the bottle supplier(s) for retesting a representative bottle from a suspect lot or resampling the suspected samples. Alternatively, validation of affected data may take into account that contaminants could be introduced by the laboratory (i.e., common laboratory solvents, sample handling artifacts, etc.) or could be a bottle QC problem. These procedures may allow an educated determination of whether the bottles, and hence the data, are still usable.

5.2 SUMMA™ Canisters

SUMMA™ canisters are used to collect whole air samples. The canister is a stainless steel sphere with its interior surface polished and deactivated by the SUMMA™ process. This process forms a pure chrome-nickel oxide layer on the interior surface. Attached to the canister are valves, with gauges in some cases, and handles which aid in sample collection. The canisters are thoroughly cleaned and leak checked prior to use. Leak checks are also performed on all canisters prior to shipping, and upon receipt at the laboratory from the field.

Regulators for use with SUMMA™ canisters for integrated or composite sampling applications will be provided by the laboratory. Permanent cleaning records for regulators are maintained. A leak check is performed on vacuum flow regulators prior to shipment.

TABLE 5-1

SAMPLING CONTAINER REQUIREMENTS, ANALYTICAL PARAMETERS, AND HOLDING TIMES

Analytical Parameters	Aqueous Samples			Soil/Sediment Samples		
	Container Type	Preservation	Holding Time	Container Type	Preservation	Holding Time
Volatile Organic Compounds	AG-TLS 4-40mL	Cool 40	7 days	G-TLC 4 oz	Cool 40	14 days
Semi-Volatile Organic Compounds	AG-TLC 2-1 liter	Cool 40	7 days * 40 days **	G-TLC 8 oz	Cool 40	14 days 40 days**
TAL Metals, Dissolved	P,G 1-1 liter	Cool 40 HNO3 to pH<2	6 mos. Hg-28 days	P,G 4 oz	Cool 40	6 mos.
Total Petroleum Hydrocarbons	G-TLC 1-1 liter	Cool 40 H2SO4 pH<2	28 days	B/ST, G-TLC 8 oz	Cool 40	14 days
TCL Pesticides/PCBs	AG-TCL 2-1 liter	Cool 40	7 days* 40 days**	G-TLC 8 oz	Cool 40	14 days* 40 days**
TAL Cyanide	P,G 250 mL	Cool 40 NaOH to pH>12	14 days	N.A.	N.A.	N.A.
Radionuclides	P 1-1 liter	HNO3 to pH<2	6 mos.	P 1-1 liter	N.A.	N.A.
Biological Oxygen Demand	P 1-1 liter	Cool 40	2 days	N.A.	N.A.	N.A.
TDS/TSS	P 1-1 liter	Cool 40	7 days	N.A.	N.A.	N.A.
Chloride, Sulfate, Fluoride	P 250 mL	Cool 40	28 days	N.A.	N.A.	N.A.
Nitrate + Nitrite	G 125 mL	Cool 40 H2SO4 pH<2	28 days	N.A.	N.A.	N.A.
COD/Ammonia	G 125 mL	Cool 40 H2SO4 pH<2	28 days	N.A.	N.A.	N.A.
Total Phosphorus	P,G 1-1 liter	Cool 40	28 days	N.A.	N.A.	N.A.
Sulfide	G 1-1 liter	Zinc Acetate to NaOH to pH>9	7 days	N.A.	N.A.	N.A.
Total Organic Carbon	N.A.	N.A.	N.A.	G 70 mL	Cool 40 H2SO4 pH<2	28 days

LEGEND:

B/ST - Brass or Steel Tube; G - Glass; AG - Amber Glass

P - Polyethylene; TLC - Teflon-lined Cap; TLS - Teflon-lined Septum;

* Extraction Holding Time ** Analysis Holding Time

6.0 SAMPLE CUSTODY

Sample custody is an organized scheme for documenting sample history and providing a legally defensible record of the measurement process. This system of documentation is one aspect of the overall internal quality control (QC) system. The types of documentation which are typically associated with environmental measurement programs include:

- Dated instrument hardcopy (e.g., strip chart records, chromatograms, etc.);
- Field data sheets;
- Field notes (dated and initialed);
- Analytical data sheets;
- "Raw" analytical data (dated and initialed);
- Summary data sheets;
- Sample logbooks;
- Records of maintenance activities;
- Chain-of-custody records; and,
- Records of deviations from and/or modifications to any measurement protocol.

All samples collected for analytical testing will be continuously tracked in the field and in transit to the laboratory by use of Chain-of-Custody forms.

6.1 Sample Documentation

During sampling, each environmental sample will have a Sample Integrity Data (SID) form completed. Each SID form will document sampling teams, time, date, location, ambient conditions, Level I or II field parameters and any other pertinent data associated with the sample collection. These SID forms are prepared for tracking purposes prior to the initiation of Chain-of-Custody forms and shipping samples off-site. SID forms will be signed by the sample team leader, following review of all information contained in the form. A duplicate SID form will not be required for split or duplicate QA samples, although both sample numbers will be noted on the SID. Relevant portions of SID forms will also be completed for trip blanks and equipment blanks. In all cases, all lines on the form must be filled in. If any lines do not apply for that particular sample, the line will be marked with "NA."

6.1.1 Field Sample Custody Procedures

Individual sample containers will be properly labeled and securely sealed prior to being placed in the cooler for shipment to the analytical laboratory. The completed chain-of-custody form will be signed, dated, enclosed in double plastic "zip-lock" type bags and placed in the ice chest prior to shipment.

Samples or evidence files are under your custody if they:

- Are in your possession;
- Are in your view, after being in your possession;
- Are in your possession and you place them in a secured location; and,
- Are in a designated secure area.

Shipping and all subsequent handling of samples off-site will be documented on the Chain-of-Custody form and the SID form. Included with the Chain-of-Custody forms will be a sample analysis request form supplied by the analytical laboratory. The sample analysis request form will specify the analytical parameters for each sample and will indicate whether the analysis is to be performed on a "rush" basis. If the laboratory supplies a combined Chain-of-Custody/Analytical Request form, it may be used in lieu of the two separate forms mentioned above. An example of a Chain-of-Custody/Analytical Request form will be provided in the addendum to the QAPP.

6.1.2 Laboratory Sample Custody Procedures

The laboratory sample custody procedures will be included in the addendum to the QAPP.

6.2 Sample Identification

During all field activities, a sample will have a unique sample number that identifies the sample and RI task number. Sample number designations for each RI task are discussed in Section 5.0 of the FSP. Once a sample is received by the laboratory it will receive a laboratory sample number that is traceable to the field number.

7.0 CALIBRATION PROCEDURES AND RECOVERY

This section describes procedures for maintaining the accuracy of all the instruments and measuring equipment which are used for conducting field tests and laboratory analyses. These instruments and equipment will be calibrated prior to each use or scheduled, periodic basis.

7.1 Field Equipment Calibration and Response Checks

Level II field analyses will be conducted for aqueous samples collected during the RI/FS. These analyses will be performed as indicated in individual sampling plans as stated in the FSP. Instruments expected to be used during the RI include: a pH meter, thermometer, specific conductivity meter, turbidity meter, and PID.

In general, field instrumentation will be user-calibrated as recommended by the manufacturer. Calibration procedures will follow the manufacturer's recommended procedures unless otherwise noted in the FSP. Copies of these procedures will be maintained with the instruments and copies of calibration records will be kept at the Golder field office for review as necessary. Those instruments that become inoperative due to the inability to maintain calibration will be marked for repair or replacement and removed from service.

7.2 Laboratory Equipment Calibration

Procedures and schedules for the calibration of laboratory equipment will be submitted by the chemical analytical laboratory in the addendum to the QAPP.

8.0 ANALYTICAL PROCEDURES

8.1 Field Analysis Procedures

During the RI, Level II field analyses will be performed using the type of instruments specified in Section 7.1. Operational procedures for these instruments will be as provided by the equipment manufacturers; copies of operational procedures will be maintained with each instrument. Table 8-1 lists anticipated Level II activities by task.

8.2 Laboratory Analysis Procedures

Table 2-2 cross references the categories of chemical analyses and analytes of interest for this investigation to the standard reference methods and detection limits established as contractual requirements between Laidlaw and the subcontractor laboratory. The detection limits are designed to meet ARARs as well as to allow a confident determination of risk posed by the site.

TABLE 8-1

ANTICIPATED LEVEL I AND II FIELD ANALYSES

Task	Activities	Anticipated Level of Analyses
Cap Investigation	Air Monitoring	Level I
Piezometer Installation	Air Monitoring	Level I
Water Levels	Air Monitoring	Level I
Well Installation	Air Monitoring	Level I
Groundwater Sampling	Air Monitoring	Level I
	pH, Turbidity, Temperature, and Specific Conductivity	Level II
Aquifer Testing	Slug and Packer Testing	Level II
Surface Water Sampling	Air Monitoring	Level I
	pH, Temperature, and Specific Conductivity	Level II
Petroleum Investigation	Soil Headspace Analysis	Level II
Sediment Sampling	Air Monitoring	Level I

9.0 INTERNAL QUALITY CONTROL CHECKS

9.1 Field Sample Collection

The assessment of field sampling precision and accuracy will be made through the collection of field duplicates/splits and equipment blanks in accordance with the procedures described in the Field Sampling Plan. Refer to Table 2-1 for a summary of sample numbers and required field QC samples.

9.2 Field Measurements

QC procedures for field measurements of pH, conductivity, turbidity, and temperature are limited to checking the reproducability of the measurements by obtaining multiple readings on a single sample or standard, and by calibrating the instruments. Refer to Table 9-1 for a summary of field QC requirements.

9.3 Laboratory Analysis

The laboratory chosen for the analysis of samples for the West Lake Landfill OU-2 RI/FS Work Plan will provide a written QA/QC program which provides rules and guidelines to ensure the reliability and validity of work conducted at the laboratory. Compliance with the QA/QC program is coordinated and monitored by the laboratory QA/QC Officer, who is independent of the operating departments. Internal quality control checks are an integral part of the analytical methods and are discussed in detail within the analytical procedures. The overall objectives of the internal quality control checks are to verify the established precision, accuracy and integrity of the methodology and to support the technical validity of the data. Where appropriate, internal quality control checks for analyses will include method blanks, preparation/reagent blanks, calibration check samples, laboratory duplicates/splits, MS/MSD and continuing calibration standards.

The required quality control frequency and performance criteria (limits) for radionuclides, gross alpha, gross beta, VOCs, SVOCs, pesticides, PCBs, metals, cyanide, TPH, TOC, and indicator parameters specified in Table 2-2 can be found in the specified methodology.

The performing laboratory will document that both initial and ongoing instrument and analytical QC functions have been met. Samples analyzed in non-conformance with the QC criteria set forth will be re-analyzed by the laboratory. It is expected that sufficient sample volume will be collected for re-analysis.

TABLE 9-1

SUMMARY OF FIELD QUALITY CONTROL REQUIREMENTS

Parameter	Audit	Frequency	Limits
pH (field)	Buffers (2)	beginning of day, every four hours or as required	+/- 0.05 pH units
	Replicates (4)	beginning of day after every ten investigative samples	maximum standard deviation of 0.1 pH unit
Specific Conductivity (field)	Standard Solutions (2)	beginning of day, every four hours as required	+/- 5% of standard
	Replicates (4)	beginning of day and after 10 investigative samples	maximum standard deviation of +/- 15%
Temperature	ASTM Thermometer	annually	maximum standard deviation of 1 degree celsius based on a minimum of 4 replicate measurements
Turbidity	Calibration	beginning of day, every 4 hours or as required	+/- 10% of standard
	Replicates	beginning of day and after every 10 samples	maximum standard deviation of +/- 15%
Photoionization Detector (PID)	Calibration	initially and as required	+/- 10% of standard
Combustible Gas Indicator (CGI)	Calibration	initially and as required	+/- 10% of standard

10.0 DATA REDUCTION, VALIDATION, AND REPORTING

10.1 Field Measurements and Sample Collection

Raw data from field measurements and sample collection activities will be appropriately recorded in the field logbook. Data will be reviewed to ensure procedures were followed and QC requirements were met, however, no formal data validation effort for field measurements will be performed. If the data are to be used in the project reports, they will be reduced onto data summary tables.

10.2 Laboratory Services

10.2.1 Data Reduction

The laboratory is responsible for identification, quantification, data reporting and data deliverables for the analyses performed. A description of the data reduction procedures for the laboratory will be included in the addendum to the QAPP. Deliverables will consist of CLP-style data packages and will include:

- Sample results with reporting limits;
- QA/QC summaries for duplicates/splits, spikes, blanks and performance evaluation samples;
- A cross reference summary;
- Copies of raw calibration data; and,
- Copies of raw sample analysis data.

10.2.2 Data Validation

The Contractor Data Reviewer will conduct a systematic review of the data for compliance with the established QC criteria based on the spike, duplicate and blank results provided by the laboratory. An evaluation of data accuracy, precision, sensitivity and completeness will be performed and presented in a technical memorandum. The general protocol for data validation are presented in the following documents:

- *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses* (EPA, June 1991 or most current version).
- *Laboratory Data Validation Functional Guidelines for Inorganic Analyses* (EPA, July 1988 or most current revision).

The Data Reviewer will identify any out-of-control data points and data omissions and interact with the laboratory to correct data deficiencies. Decisions to repeat sample collection and analyses may be made by the Project Manager based on the extent of the deficiencies and their importance in the overall context of the project.

10.2.3 Data Reporting

The laboratory reporting scheme for the collection of raw data through the storage of this data, record keeping requirements for laboratory notebooks, and key personnel who will handle and report data for the laboratory will be identified in the Addendum to the QAPP. Laboratory deliverables and data validation memoranda will be sent upon request to the EPA Project Manager.

Analytical data generated for the West Lake Landfill OU-2 RI will be computerized in a format organized to facilitate data review and evaluation. The computerized data set will include the data qualifiers provided by the performing laboratory.

The laboratory-provided qualifiers will include such items as:

- Nondetects;
- Sample Quantitation Limits;
- Estimated concentration due to poor QC data;
- Concentrations of chemicals found in the laboratory blank.

11.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the Field Sampling Plan and QAPP. The audits of field and laboratory activities include two separate independent parts: internal and external audits.

11.1 Field Audits

11.1.1 Internal Audits

Internal audits of field activities (sampling and measurements) will be conducted by the Golder QA Officer and/or his designee. The purpose of the field audit will be to evaluate and document adherence to procedures described in the QAPP and Field Sampling Plan. The audit will include review of field activities, sample documentation, Chain-of-Custody forms, field logbooks, and sampling and decontamination activities. A checklist to be used as a protocol for the field activities audit is included in Attachment 1 of this QAPP. Copies of the completed checklist will be forwarded to the Golder Project Manager and the EPA Project Manager.

11.1.2 External Audits

The EPA will be responsible for conducting external audits.

11.2 Laboratory Audits

11.2.1 Internal Audits

The purpose of the internal audit is to evaluate and document adherence to laboratory analytical procedures described in this QAPP. The respondent (or Golder) will be responsible for performing internal audits. Audits will include examination of laboratory documentation on sample receiving, sample log-in, sample storage, Chain-of-Custody procedure, sample preparation and analysis, instrument operating records, etc., and will be performed annually. Performance audits consisting of QC samples prepared and submitted to the laboratory for analysis will be performed quarterly. Results of these QC samples will be reviewed by the laboratory QA Officer.

11.2.2 External Audits

The EPA may audit performing laboratories and provide recommendations for approval of the laboratory for the requested analyses to the EPA Project Manager. The audit may consist of a review of analytical and Chain-of-Custody procedures, evaluation of performance samples and may also include an on-site audit of the laboratory.

12.0 PREVENTIVE MAINTENANCE

12.1 Field Equipment Maintenance

Maintenance requirements are specified in the calibration/maintenance intervals established by the equipment manufacturer. In addition, field equipment will be inspected daily for indications of malfunctions. Routine maintenance for such things as low batteries, loose cables, bad fluids, and dried or cracked membranes be will performed as required. Sufficient supplies of the materials necessary for this maintenance will be kept on hand to prevent unnecessary delay to the field sampling program.

12.2 Laboratory Equipment Maintenance

Laboratory equipment will also undergo preventive maintenance to minimize downtime and to ensure quality analysis. A laboratory equipment maintenance description will be submitted in the Addendum to the QAPP.

13.0 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

13.1 Field Measurements

Field data will be assessed by the Golder Field Manager. The Golder Field Manager will review the field results for compliance with the established QC criteria that are specified in this QAPP and the FSP. Accuracy of the field measurements will be assessed using daily instrument calibration, calibration check and analyses of blanks. Precision will be assessed on the basis of reproducability by multiple readings of a single sample. Data completeness will be calculated using Equation 13-1:

$$completeness = \frac{Valid\ Data\ Obtained}{Total\ Data\ Planned} * 100 \qquad \text{Eq. 13-1}$$

13.2 Laboratory Data

Laboratory results will be assessed for compliance with required precision, accuracy, completeness and sensitivity as follows:

13.2.1 Precision

Precision of laboratory analysis will be assessed by comparing the analytical results between laboratory matrix spike/matrix spike duplicate (MS/MSD) for organic analysis and laboratory duplicate/split analyses for inorganic analysis. The relative percent difference (%RPD) will be calculated for each pair of duplicate/split analyses using Equation 13-2:

$$\%RPD=\left(\frac{S-D}{(S+D)/2}\right)*100 \qquad \text{Eq. 13-2}$$

Where: S = First sample value (original or MS value)
D = Second sample value (duplicate or MSD value)

13.2.2 Accuracy

Accuracy of laboratory results will be assessed for compliance with the established QC criteria that are described in Section 4.0 of this QAPP using the analytical results of method blanks, reagent/preparation blank, matrix spike/matrix spike duplicate samples, equipment blank and bottle blanks. The percent recovery (%R) of matrix spike samples will be calculated using Equation 13-3:

$$\%R=\left(\frac{A-B}{C}\right)*100 \qquad \text{Eq. 13-3}$$

Where: A = The analyte concentration determined experimentally from the spiked sample;
B = The background level determined by a separate analysis of the unspiked sample; and,
C = The amount of the spike added.

13.2.3 Completeness

The data completeness of laboratory analyses results will be assessed for compliance with the amount of data required for decision making. The completeness is calculated using Equation 13-1.

13.2.4 Sensitivity

The achievement of method detection limits depend on instrumental sensitivity and matrix effects. Therefore, it is important to monitor the instrumental sensitivity to ensure the data quality through constant instrument performance. The instrumental sensitivity will be monitored through the analysis of method blank, calibration check sample, laboratory control samples, etc.

14.0 CORRECTIVE ACTION

Corrective actions may be required for two classes of problems; analytical and equipment problems and noncompliance problems. Analytical and equipment problems may occur during sampling and sample handling, sample preparation, laboratory instrumental analysis and data review.

For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the Golder QA Officer. If the problem is analytical in nature, information on these problems will be promptly communicated to the EPA Project Manager. Implementation of corrective action will be confirmed in writing through the same channels.

Any nonconformance with the established quality control procedures in the QAPP or FSP will be identified and corrected in accordance with the QAPP. The EPA Project Manager or his designee will issue a Nonconformance Report for each nonconformance condition.

Corrective actions will be implemented and documented in the field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped by stop-work order by the Golder QA Officer or EPA Project Manager.

14.1 Sample Collection/Field Measurements

Technical staff and project personnel will be responsible for reporting all suspected technical or QA nonconformances or suspected deficiencies of any activity or issued document by reporting the situation to the Golder Project Manager or designee. This manager will be responsible for assessing the suspected problems in consultation with the Golder QA Officer and making a decision based on the potential for the situation to impact the quality of the data. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated by the manager.

The manager will be responsible for ensuring that corrective action for nonconformances are initiated by:

- Evaluating reported nonconformances;
- Controlling additional work on nonconforming items;
- Determining disposition or action to be taken;
- Maintaining a log of nonconformances;
- Reviewing nonconformance reports and corrective actions taken; and,
- Ensuring nonconformance reports are included in the final site documentation in project files.

If appropriate, the Golder Project Manager will ensure that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed.

Corrective action for field measurements may include:

- Repeat the measurement to check the error;
- Check for proper adjustments for ambient conditions such as temperature;
- Check the batteries;
- Re-calibration;

- Check the calibration;
- Replace the instrument or measurement devices; and,
- Stop work (if necessary).

The Golder Project Manager or his designee is responsible for West Lake Landfill OU-2 site activities. In this role, the Golder Project Manager, at times, is required to adjust the site programs to accommodate site specific needs. When it becomes necessary to modify a program, the responsible person obtains the approval of the Golder Project Manager before implementing the necessary changes. The change in the program will be documented and signed by the initiators and the Golder Field Manager or his designee.

The Golder Project Manager for the West Lake Landfill OU-2 RI/FS Work Plan is responsible for the controlling, tracking and implementation of the identified changes. Reports on changes will be distributed to affected parties including the EPA Project Manager.

14.2 Laboratory Analyses

Corrective actions are required whenever an out-of-control event or potential out-of-control event is noted. The investigative action taken is somewhat dependent on the analysis and the event.

Laboratory personnel are alerted that corrective actions may be necessary if:

- QC data are outside the warning or acceptable windows for precision and accuracy;
- Blanks contain target analytes above acceptable levels;

- Undesirable trends are detected in spike recoveries or RPD between duplicates/splits;

- There are unusual changes in detection limits;

- Deficiencies are detected by the QA Department during internal or external audits or from the results of performance evaluation samples; or,

- Inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, instrument sensitivity, etc. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager and/or QA department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the QA department

15.0 QUALITY CONTROL REPORTS TO MANAGEMENT

As previously stated in Sections 11.0 and 14.0, project activities will be regularly assessed by auditing and surveillance processes. Surveillance, nonconformance, audit, and corrective action documentation will be routed to the project quality records upon completion or closure. A report summarizing all audit, surveillance, and instruction change authorization activity, as well as any associated corrective actions, will be prepared by the QA Manager at the completion of the investigation and/or as indicated by the Laidlaw reporting milestones discussed below. The report(s) will be submitted to the Project Manager for incorporation into the milestone and final reports. Each report will include an assessment of the overall adequacy of the total measurement system with regard to the data quality objectives of the investigation.

To facilitate project communication between Laidlaw and the EPA, Laidlaw and the EPA have agreed on specific reporting requirements and milestone events incorporated in the Administrative Order which are delineated in Section 3.0 of the Work Plan. These reporting requirements are incorporated herein by reference. A milestone chart summarizing the approved schedule is presented in the RI/FS Work Plan.

ATTACHMENT 1

FIELD ACTIVITIES AUDIT CHECKLIST

GOLDER ASSOCIATES' INTERNAL FIELD AUDIT
GROUNDWATER SAMPLING

Date of Field Audit: ______________________

Person Conducting Audit: ______________________

Sampling Team Audited: ______________________
____
____

Monitoring Well(s) Sampled: ______________________

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION
SAMPLING DOCUMENTS		
	Field Sampling Plan.	
	Health & Safety Plan.	
	Quality Assurance Project Plan.	
	Monitoring well construction diagrams.	
	Calculations of well volumes for purging.	
	Bound log book.	
SAMPLING ASSIGNMENTS		
	Sample bottle assignment.	

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION
	Equipment preparation.	
	Paperwork preparation.	
	Instrument calibration.	
	Communications	
	Vehicles	
	Site map displayed.	
	Sample collection tracking.	
	Sample log book.	
	Field manager log book.	
	Field form completion.	
	Chain of Custody - field.	
	Work zone set up.	
GROUNDWATER SAMPLING EQUIPMENT AND MATERIALS		
	PID, and calibration kit.	
	OVM and calibration kit.	
	Water level indicator.	
	Specific conductance meter.	
	Thermometer.	
	Turbidity meter.	
	pH probe.	

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION
	Bailer(s) or sampling pump(s), stainless steel or teflon tubing, connections or material.	
	In-line filtering apparatus with 0.45 micron filter.	
	Sample bottles and preservatives for TCL parameters. - as outlined in Field Sampling Plan.	
	Sample bottles and preservatives for TOC. - as outlined in Field Sampling Plan.	
	Sample bottles and preservative for TAL parameters. - as outlined in Field Sampling Plan.	
	Sample bottles and preservatives for Water Quality Parameters. - as outlined in Field Sampling Plan.	
	Field forms: - chain-of-custody/request for analysis - sample labels - shipping forms	
	Coolers and ice packs.	
	Packaging tape.	

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION
SAMPLING PROCEDURES		
	Plastic sheeting placed around well head to prevent possible contamination of sampling equipment.	
	Field equipment calibrated and calibrations documented. Calibration procedures are correct: - PID - specific conductance (SC) - turbidity - pH	
	Purging of Monitoring Well: - equipment decontaminated as per Section 10.0 of FSP. - water level measurement taken. - three well volumes removed. - temperature stabilized as per Section 3.4.3 of FSP. - pH stabilized as per Section 3.4.3 of FSP. - SC stabilized as per Section 3.4.3 of FSP. - purging method? - purge water containerized?	
	Environmental Samples: - sampling equipment decontaminated as per Section 10.0 of FSP - decontamination fluids containerized. - headspace analysis on partially filled container - pH measured - turbidity measured - temperature measured - SC measured	

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION
	Environmental Samples (continued): - both filtered and unfiltered TAL metals. - TAL metals filtered with 0.45 micron in-line filter. - VOA vials have no headspace. - method to collect samples (pump or bailer). Procedures as per Section 3.4.3 of FSP. - samples labeled appropriately. - samples placed immediately in ice filled coolers.	
	QA/QC Samples (if appropriate for the well being field audited): - field blank prepared using laboratory supplied water and same collection equipment as environmental samples, and correct labelling. - field duplicate with correct labelling. - MS/MSD with correct labelling. - samples placed immediately in ice filled coolers.	
	Sample Shipping: - trip blank shipped with VOA environmental samples. - chain-of-custody filled out and included with samples. - ice packs included in cooler. - samples packaged to minimize possibility of damage. - samples shipped the same day as collection. - samples forms specify next day delivery.	

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION
HEALTH & SAFETY		
	Health & Safety meeting	
	- Contaminants of Concern (Rates of Exposure)	
	- Action limit	
	Daily sign in/out sheet	
	Work zone entry/exit logs	
	Instrument calibration	
	Equipment storage	
	Work zone set up	
	MSDS	
	OSHA Poster	
	Personnel Paperwork	
	- 40 hour	
	- 8 hour refresher	
	- Medical monitoring	
	- Fit test records	
	Phone numbers - emergency	
	Hospital route map	
	Contaminant reduction Zone	
	- eyewash	

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION
	- 1st aid	
	- towels	
	- garbage bag	
	- decon supplies	
	- fire extinguisher	
	Personnel decon	
	Support zone - uncontaminated	
	Personal protective equipment	
	15 minute eyewash	
	Vehicles	
	Fire extinguisher	
	1st aid	
	Eye wash	
	Heat stress - cold exposure	
	Work - rest regimes	
	Accident report form	
	Health & Safety Plan sign sheet	
	Health & Safety meeting sign sheet	
	1st Aid & CPR Personnel	
	- Bee strings	
	- Frostbite	

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION
	- Heat stress	
FIELD LOG BOOK ENTRY		
	Date, start time noted	
	Temperature, weather conditions	
	Barometric pressure	
	List of field personnel on site	
	Level of protection	
	Film roll number and number of photos at each site recorded	
	List of field equipment used, with date of last calibration noted "Significant" observations	
	List of visitors, purpose	
	All field measurement made recorded	
	Description of sample collected and location	
	Time of sample collection, depth, volume collected, number of bottles filled	
	Signature of person entering in log	
	Countersignature	
SAMPLE PACKING		
	Separate QC lab samples from QA lab samples, lit on separate custody forms	

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION
	Label number matches tag number on bottle	
	Notation of preservative added on tag and label	
	Put bottles in ziplocks	
	Check custody form against cooler contents	
	Tag and label number recorded on custody form	
	Tag info matches label info matches custody form	
	Glass bottles in foam sleeves	
	Set aside custody seal numbers for sealing cooler	
	Date, sign, time on custody form, add custody seal numbers to be used on form	
	Put custody form and return address label in ziplock, tape to inside lid	
	"This end up" stickers (all four sides)	
	Arrow stickers (all four sides)	
	Fragile stickers (all four sides and top)	
	Address label (top), cover with clear tape	
	Custody seals over latches, cover with clear tape	
	Seal cooler with strapping tape, do not obliterate stickers, address or seals	
TELEPHONE CALLS		
	Calls Project Manager	

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION
	Get UPS confirmation numbers for shipment, get date, arrival time of coolers at labs	
	Call lab to obtain number of coolers, date and time of arrival	

Check If Aspect Is Correct	ASPECT	COMMENTS NONCONFORMANCE/DISPOSITION/CORRECTIVE ACTION

ADDITIONAL COMMENTS/RECOMMENDATIONS:

(65136886.wp1/srh)